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(54) Title: SELECTIVE β_3 ADRENERGIC AGONISTS			
<p style="text-align: right;">(1)</p>			
(57) Abstract			
<p>The present invention is in the field of medicine, particularly in the treatment of Type II diabetes and obesity. More specifically, the present invention relates to selective β_3 receptor agonists useful in the treatment of Type II diabetes and obesity. The invention provides compounds and methods of treating Type II diabetes and obesity, comprising administering to a mammal in need thereof compounds of formula (I).</p>			

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Selective β_3 Adrenergic Agonists

This application claims the benefit of U.S. Provisional Application 60/025,818 filed September 5, 1996 and U.S. Provisional Application 60/029,228 filed October 30, 1996.

Field of Invention

The present invention is in the field of medicine, particularly in the treatment of Type II diabetes and obesity. More specifically, the present invention relates to selective β_3 adrenergic receptor agonists useful in the treatment of Type II diabetes and obesity.

Background of the Invention

The current preferred treatment for Type II, non-insulin dependent diabetes as well as obesity is diet and exercise, with a view toward weight reduction and improved insulin sensitivity. Patient compliance, however, is usually poor. There are no currently approved medications that adequately treat either Type II diabetes or obesity. The invention described herein is directed toward an effective and timely treatment for these serious diseases.

One therapeutic opportunity that has been recently recognized involves the relationship between adrenergic receptor stimulation, anti-hyperglycemic effects, and metabolic events such as increased basal metabolic rate. Compounds that act as β_3 adrenergic receptor agonists have been shown to exhibit a marked effect on lipolysis, thermogenesis, and serum glucose levels in animal models of Type II (non-insulin dependent) diabetes.

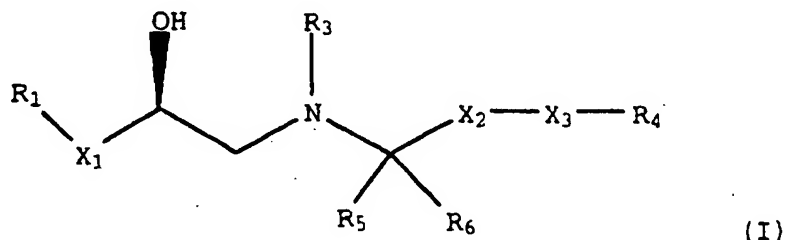
The β_3 receptor, which is found in several types of human tissue including human fat tissue, has roughly 50% homology to the β_1 and β_2 receptor subtypes yet is

considerably less abundant. The importance of the β_3 receptor is a relatively recent discovery since the amino-acid sequence of the human receptor was only elucidated in the late 1980's. A large number of publications have appeared in recent years reporting success in discovery of agents that stimulate the β_3 receptor. Despite these recent developments there remains a need to develop a selective β_3 receptor agonist which has minimal agonist activity against the β_1 and β_2 receptors.

10 The present invention provides methods of treating
Type II diabetes, treating obesity, and stimulating the β_3
receptor. In addition, the present invention also provides
novel compounds that are selective β_3 receptor agonists and
as such are useful for treating Type II diabetes, obesity,
15 and stimulating the β_3 receptor. U.S. patent number
4,503,067 discloses carbazoyl-(4)-oxypropanolamine
compounds, some of which are within the scope of formula I,
as β -adrenoceptor antagonists and vasodilators.

20 Summary of Invention

The present invention provides methods of treating Type II diabetes, treating obesity, and stimulating the β_3 receptor which comprise administering to a patient in need thereof a compound described in Formula I below.



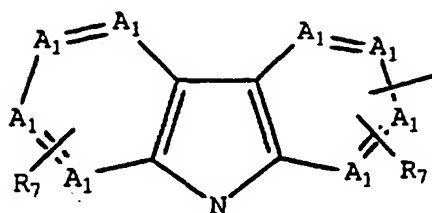
wherein:

X₁ is -OCH₂-, -SCH₂-, or a bond;

X₂ is a bond, or a 1 to 5 carbon straight or
30 branched alkylene;
X₃ is O, S, or a bond;

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R₁ is a fused heterocycle of the formula:

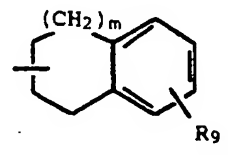
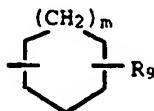
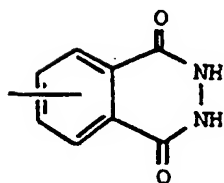
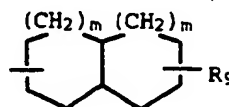
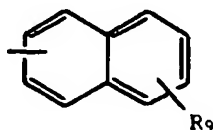
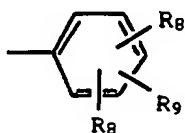


5 the A₁ groups are independently carbon or nitrogen, provided that no more than 2 nitrogens may be contained in either fused 6 membered ring and those 2 nitrogens may not be adjacent;

10 R₂ is independently hydrogen, C₁-C₄ alkyl, or aryl;

R₃ is hydrogen or C₁-C₄ alkyl;

R₄ is an optionally substituted heterocycle or a moiety selected from the group consisting of:



15

R₅ is hydrogen or C₁-C₄ alkyl;

R₆ is hydrogen, C₁-C₄ alkyl, or CO₂(C₁-C₄ alkyl);

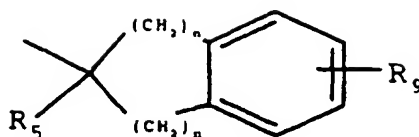
20 or R₅ and R₆ combine with the carbon to which each is attached to form a C₃-C₆ cycloalkyl;

or R₆ combines with X₂ and the carbon to which each is attached to form a C₃-C₈ cycloalkyl;

or R₆ combines with X₂, R₄, and the carbon to which each is attached to form:

25

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provided that R₅ is hydrogen;

R₇ is independently hydrogen, halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONR₂R₂, NHCOR₂,
 5 C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂;

R₈ is independently hydrogen, halo, or C₁-C₄ alkyl;

R₉ is hydrogen, halo, hydroxy, CN, OR₁₀, C₁-C₄ alkyl, C₁-C₄ haloalkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl
 10 or C₁-C₄ alkoxy), SR₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂, SOR₂, NR₁₁R₁₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂;

R₁₀ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈
 15 cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted cycloalkyl, (CH₂)_n optionally substituted aryl, (CH₂)_n optionally substituted heterocycle, or (CH₂)_nCO₂R₂;

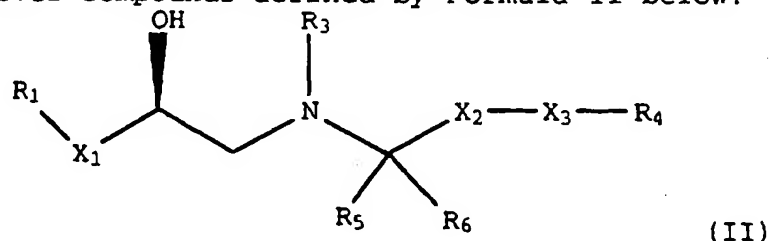
R₁₁ and R₁₂ are independently hydrogen, C₁-C₄
 20 alkyl, aryl, (CH₂)_naryl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl;

m is 0 or 1; and

n is independently 0, 1, 2, or 3;

25 or a pharmaceutically acceptable salt thereof.

Another embodiment of the present invention is the genus of novel compounds defined by Formula II below.



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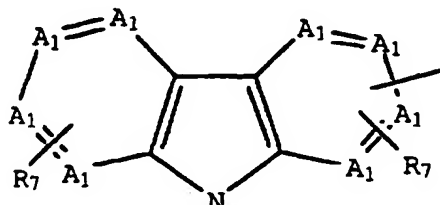
wherein:

X₁ is -OCH₂-, -SCH₂-, or a bond;

X₃ is O, S, or a bond;

R₁ is a fused heterocycle of the formula:

5

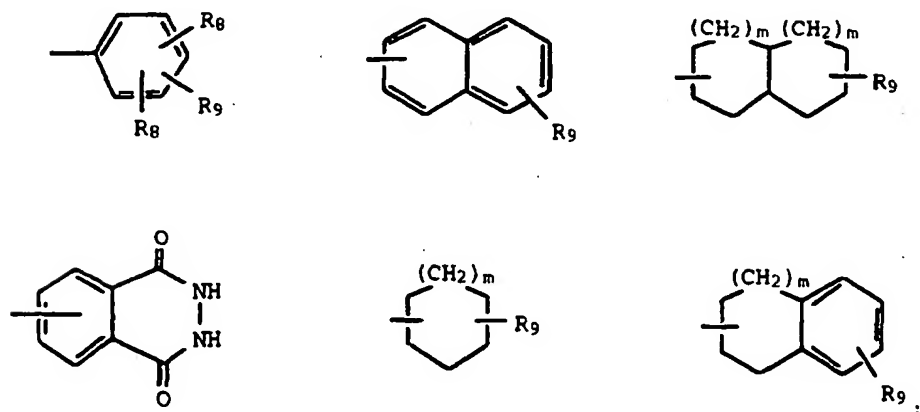


the A₁ groups of said heterocycle are independently carbon or nitrogen, provided that no more than 2 nitrogens may be contained in either fused 6 membered ring and those 2 nitrogens may not be adjacent;

R₂ is independently hydrogen, C₁-C₄ alkyl, or aryl;

R₃ is hydrogen or C₁-C₄ alkyl;

R₄ is an optionally substituted heterocycle or a moiety selected from the group consisting of:



X₂ is a bond, or a 1 to 5 carbon straight or branched alkylene;

R₅ is hydrogen or C₁-C₄ alkyl;

R₆ is hydrogen, C₁-C₄ alkyl, or CO₂(C₁-C₄ alkyl);

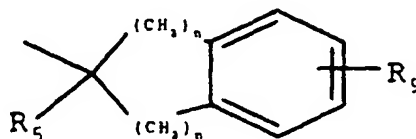
or R₅ and R₆ combine with the carbon to which each is attached to form a C₃-C₆ cycloalkyl;

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or R₆ combines with X₂ and the carbon to which each is attached to form a C₃-C₈ cycloalkyl;

or R₆ combines with X₂, R₄, and the carbon to which each is attached to form:

5



provided that R₅ is hydrogen;

R₇ is independently hydrogen, halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONHR₂, NHCOR₂,
 10 C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂;

R₈ is independently hydrogen, halo or C₁-C₄ alkyl;

R₉ is halo, CN, OR₁₀, C₁-C₄ alkyl, C₁-C₄ haloalkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl or C₁-C₄ alkoxy), SR₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂,
 15 SOR₂, NR₁₁R₁₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂;

R₁₀ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted cycloalkyl, (CH₂)_n optionally substituted aryl, (CH₂)_n optionally substituted heterocycle, or (CH₂)_nCO₂R₂;
 20

R₁₁ and R₁₂ are independently hydrogen, C₁-C₄ alkyl, aryl, (CH₂)_naryl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl;
 25

m is 0 or 1;

n is independently 0, 1, 2, or 3;

provided:

30 when R₅ or R₆ is hydrogen; either
 1) one or more A₁ must be nitrogen,

or

2) R₉ is CN, OR₁₀, CO₂R₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂NR₁₁R₁₂, optionally substituted aryl,

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optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂; and

R₁₀ is C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted
5 cycloalkyl, (CH₂)_n optionally substituted aryl, or (CH₂)_n optionally substituted heterocycle;
or a pharmaceutically acceptable salt thereof.

The present invention also provides novel processes for making, as well as novel pharmaceutical
10 formulations of the compounds of Formula II.

The compounds of Formula I are selective β_3 receptor agonists and as such are useful for treating Type II diabetes and obesity, as well as useful for stimulating or activating the β_3 receptor. Therefore, the present
15 invention also provides for methods of treating Type II diabetes and obesity, as well as a method of stimulating or activating the β_3 receptor.

In addition, the present invention provides the use of compounds of Formulas I for treating Type II diabetes
20 and obesity as well the use of compounds of Formulas I for stimulating or activating the β_3 receptor.

In addition, compounds of Formula I can be used to prepare a medicament useful for the treatment of Type II diabetes, the treatment of obesity, and the stimulation or
25 activation of the β_3 receptor.

Detailed Description

For the purposes of the present invention, as disclosed and claimed herein, the following terms are
30 defined below. As they relate to the present invention, the terms below may not be interpreted, individually or collectively, to describe chemical structures that are unstable or impossible to construct.

The term "halo" represents fluorine, chlorine,
35 bromine, or iodine.

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The term "C₁-C₄ alkyl" represents a cyclo, straight or branched chain alkyl group having from one to four carbon atoms such as methyl, ethyl, n-propyl, isopropyl, cyclopropyl, n-butyl, isobutyl, sec-butyl, t-butyl and the like. A "haloalkyl" is one such alkyl substituted with one or more halo atoms, preferably one to three halo atoms. An example of a haloalkyl is trifluoromethyl. An "alkoxy" is a alkyl group covalently bonded by an -O- linkage.

10 The term "1 to 5 carbon straight or branched alkylene" represents a one to five carbon, straight or branched, alkylene moiety. A branched alkylene may have one or more points of branching. A 1 to 5 carbon straight or branched alkylene may optionally be unsaturated at one or
15 more carbons. Thus, a 1 to 5 carbon straight or branched alkylene includes 1 to 5 carbon alkylene, alkenylene and alkylidene moieties. Examples include methylene, ethylene, propylene, butylene, -CH(CH₃)CH₂-CH(C₂H₅)CH₂-, -CH(CH₃)CH(CH₃)-, -CH₂C(CH₃)₂-, -CH₂CH(CH₃)CH₂-, -C(CH₃)₂CH=,
20 -CH=CHCH₂-, -CH=CH-, and the like.

The "acyl" moiety, alone or in combination, is derived from an alkanoic acid containing from one to seven carbon atoms. The term "acyl" also includes moieties derived from an aryl carboxylic acid.

25 The term "aryl" represents an optionally substituted or unsubstituted phenyl or naphthyl. The term (CH₂)_naryl is preferably benzyl or phenyl.

The term "optionally substituted" or "substituted" as used herein means an optional substitution of one to
30 three, preferably one or two groups independently selected from halo, C₁-C₄ haloalkyl, hydroxy, carboxy, tetrazolyl, acyl, COOR₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkoxy), cyano, C₁-C₄ alkoxy, C₁-C₄ alkyl, phenyl, benzyl, nitro, NR₁₁R₁₂, NHCO(C₁-C₄ alkyl), NHCO(benzyl), NHCO(phenyl), SR₂, S(C₁-C₄
35 alkyl), OCO(C₁-C₄ alkyl), SO₂(NR₁₁R₁₂), SO₂(C₁-C₄ alkyl), or SO₂(phenyl).

R₂ is independently hydrogen, C₁-C₄ alkyl, or aryl.

R₁₁ and R₁₂ are independently H, C₁-C₄ alkyl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl.

The term "heterocycle" represents a stable, optionally substituted or unsubstituted, saturated or unsaturated 5 or 6 membered ring, said ring having from one to four heteroatoms that are the same or different and that are selected from the group consisting of sulfur, oxygen, and nitrogen; and when heterocycle contains two adjacent carbon atoms, the adjacent carbon atoms may be structured to form a group of the formula -CH=CH-; provided that (1) when the heterocyclic ring contains 5 members, the heteroatoms comprise not more than two sulfur or two oxygen atoms but not both; and (2) when the heterocyclic ring contains 6 members and is aromatic, sulfur and oxygen are not present. The heterocycle may be attached at any carbon or nitrogen which affords a stable structure. The heterocycle may be optionally substituted. Examples of a heterocycle include but are not limited to pyrazole, pyrazoline, imidazole, isoxazole, triazole, tetrazole, oxazole, 1,3-dioxolone, thiazole, oxadiazole, thiadiazole, pyridine, pyrimidine, piperazine, morpholine, pyrazine, pyrrolidine, piperidine, oxazolidone, oxazolidinedione, imidazolidinone, and the like.

The term "leaving group" as used in the specification is understood by those skilled in the art. Generally, a leaving group is any group or atom that enhances the electrophilicity of the atom to which it is attached for displacement. Preferred leaving groups are p-nitrobenzene sulfonate, triflate, mesylate, tosylate, imidate, chloride, bromide, and iodide.

The term "pharmaceutically effective amount", as used herein, represents an amount of a compound of the invention that is capable of stimulating the β_3 receptor in

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mammals. The particular dose of the compound administered according to this invention will, of course, be determined by the particular circumstances surrounding the patient, including the compound administered, the route of administration, the particular condition being treated, and similar considerations.

The term "unit dosage form" refers to physically discrete units suitable as unitary dosages for human subjects and other mammals, each unit containing a predetermined quantity of active material calculated to produce the desired therapeutic effect, in association with a suitable pharmaceutical carrier.

The term "treating," as used herein, describes the management and care of a patient for the purpose of combating the disease, condition, or disorder and includes the administration of a compound of present invention to prevent the onset of the symptoms or complications, to alleviate the symptoms or complications, or to eliminate the disease, condition, or disorder.

The term "selective" means preferential agonism or stimulation of the β_3 receptor over agonism of the β_1 or β_2 receptor. In general, the compounds demonstrate a minimum of a twenty fold differential (preferably over a 50x differential) in the dosage required to behave as an agonist to the β_3 receptor and the dosage required for equal agonism of the β_1 and β_2 receptors as measured in the Functional Agonist Assay. The compounds demonstrate this differential across the range of doses. Thus, β_3 selective compounds behave as agonists for the β_3 receptor at much lower concentrations with lower toxicity by virtue of their minimal agonism of the other receptors.

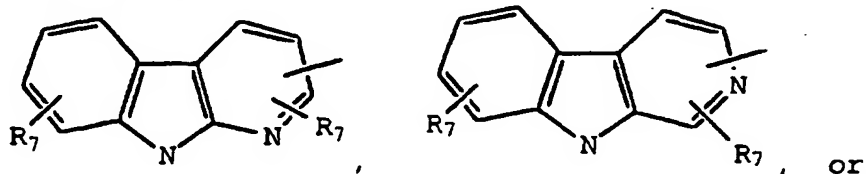
The term "stimulating", as used herein, means affecting, activating, or agonizing the β_3 receptor to elicit a pharmacological response. The stimulation or activation of the receptor may be either complete or partial relative to a known stimulating agent such as isoproterenol.

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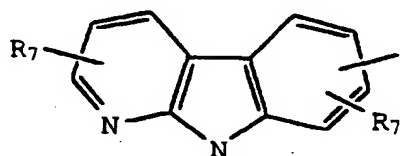
As previously noted, the present invention provides a method of treating type II diabetes and obesity, comprising administering to a mammal in need thereof compounds of the Formula I.

5 Preferred embodiments of the present invention are set out in paragraphs below.

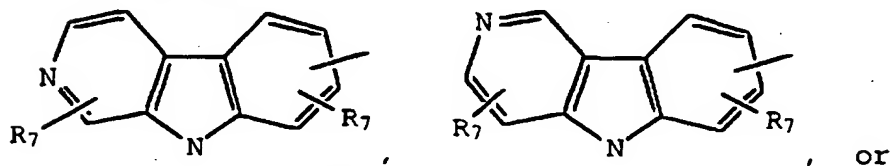
(a) R_1 is



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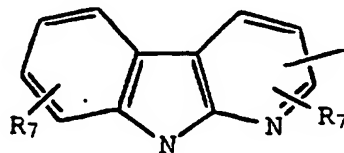


(b) R_1 is

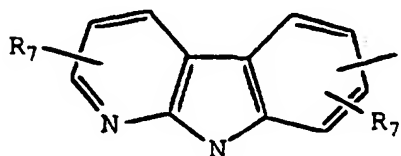


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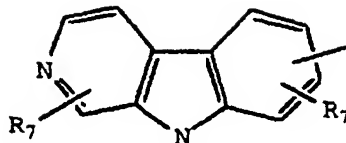
(c) R_1 is



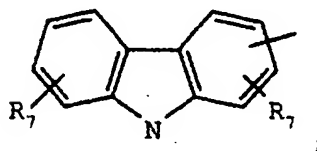
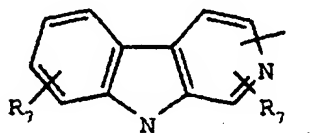
(d) R_1 is



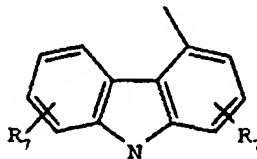
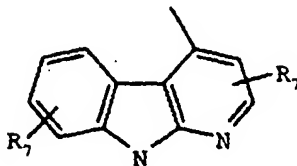
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(e) R_1 is

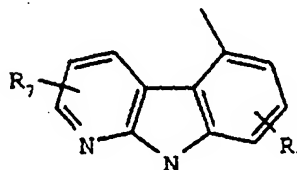
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(f) R_1 is(g) R_1 is

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(h) R_1 is attached to X_1 in the 4 position.(i) R_1 is(j) R_1 is

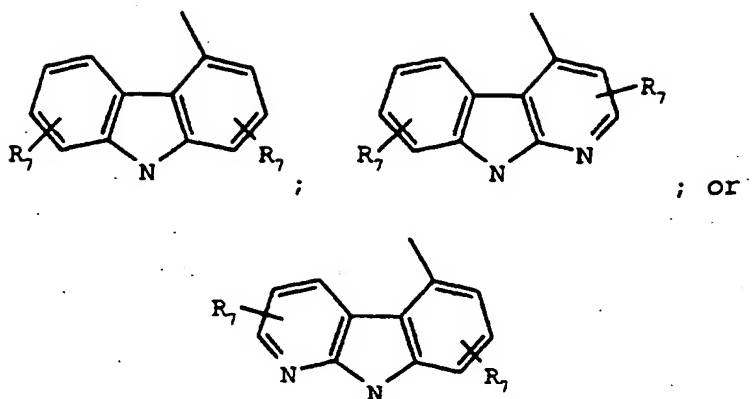
15

(k) R_1 is

20

(l) R_1 is

-13-



5 (m) X_1 is $-OCH_2-$, the oxygen of which is attached to R_1 .

(n) X_1 is a bond.

(o) R_3 is methyl.

(p) R_3 is hydrogen.

10 (q) R_5 is methyl or ethyl.

(r) R_6 is methyl or ethyl.

(s) R_5 and R_6 are both methyl.

(t) R_5 and R_6 are both hydrogen.

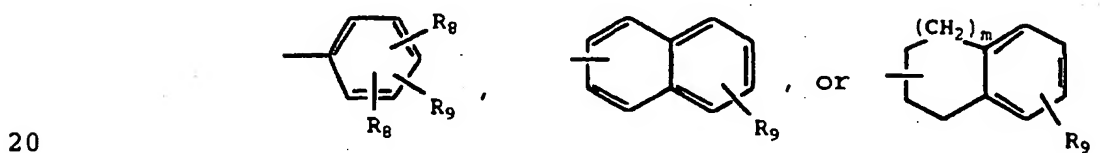
(u) X_2 is isopropylene, methylene, or ethylene.

15 (v) X_2 is isopropylene

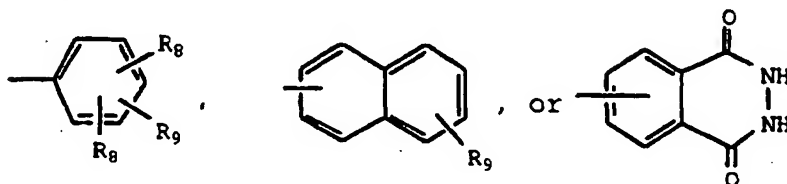
(w) X_2 is methylene.

(x) X_2 is ethylene.

(y) R_4 is

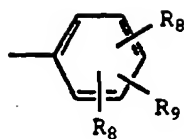
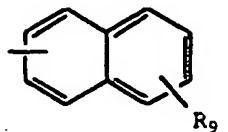


(z) R_4 is



(ab) R_4 is

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(ac) R₄ is(ad) R₈ is halo.5 (ae) R₈ is hydrogen.

(af) R₉ is halo, CN, OR₁₀, C₁-C₄ alkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl or C₁-C₄ alkoxy), NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂, SOR₂, optionally substituted aryl, optionally substituted heterocycle.

10 (ag) R₉ is CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl or C₁-C₄ alkoxy), NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂.

15 (ah) R₉ is halo, CN, C₁-C₄ haloalkyl, SR₂, CSNR₂, CSNR₁₁R₁₂, SO₂R₂, SO₂NR₁₁R₁₂, SOR₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂.

20 (ai) R₉ is OR₁₀, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂.

(aj) R₉ is NR₂SO₂R₂.(ak) R₉ is CN.(al) R₉ is CONR₁₁R₁₂.(am) R₉ is OR₁₀.

25 (an) R₁₀ is (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, said aryl, C₃-C₈ cycloalkyl, or heterocycle being optionally substituted.

(ao) R₁₀ is (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_nheterocycle, said C₃-C₈ cycloalkyl, or heterocycle
30 being optionally substituted.

(ap) R₁₀ is (CH₂)_nheterocycle said heterocycle being unsubstituted or optionally substituted.

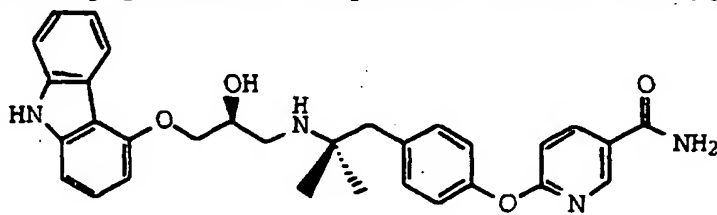
-15-

- (aq) R₁₀ is aryl.
(ar) R₁₀ is pyridyl.
(as) R₁₀ is aryl substituted with CONR₁₁R₁₂, CN, CO₂R₂, or NR₂SO₂R₂.
5 (at) R₁₀ is pyridyl substituted with CONR₁₁R₁₂, CN, CO₂R₂, or NR₂SO₂R₂.
(au) R₁₀ is aryl substituted with CONR₁₁R₁₂.
(av) R₁₀ is aryl substituted with CN.
(ax) R₁₀ is aryl substituted with CO₂R₂. (ay)
10 R₁₀ is aryl substituted with NR₂SO₂R₂.
(az) R₁₀ is pyridyl substituted with CONR₁₁R₁₂.
(ba) R₁₀ is pyridyl substituted with CN.
(bb) R₁₀ is pyridyl substituted with CO₂R₂. (bc)
R₁₀ is pyridyl substituted with NR₂SO₂R₂.
15 (bd) Preferred optional substitution is halo, C₁-C₄ haloalkyl, hydroxy, carboxy, tetrazolyl, acyl, COOR₂, CONR₁₁R₁₂, cyano, C₁-C₄ alkoxy, C₁-C₄ alkyl, phenyl, benzyl, nitro, NR₁₁R₁₂, NHCO(benzyl), SO₂(C₁-C₄ alkyl), or SO₂(phenyl).
20 (be) Other preferred optional substitution is halo, C₁-C₄ haloalkyl, hydroxy, carboxy, tetrazolyl, acyl, COOR₂, CONR₁₁R₁₂, cyano, C₁-C₄ alkoxy, C₁-C₄ alkyl, phenyl, nitro, or NR₁₁R₁₂.
25 (bf) Other preferred optional substitution is halo, hydroxy, carboxy, acyl, COOR₂, CONR₁₁R₁₂, cyano, C₁-C₄ alkoxy, C₁-C₄ alkyl, phenyl, or NR₁₁R₁₂.
(bg) Other preferred optional substitution is halo, hydroxy, acyl, C₁-C₄ alkoxy, C₁-C₄ alkyl, or
30 phenyl.
(bh) Preferred halo groups include bromine, chlorine, or fluorine.
(bi) Other preferred halo groups include chlorine or fluorine.
35 (bj) Most preferred halo groups include fluorine.

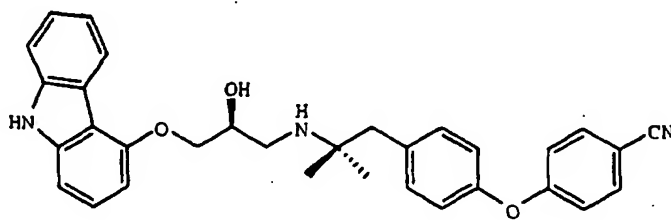
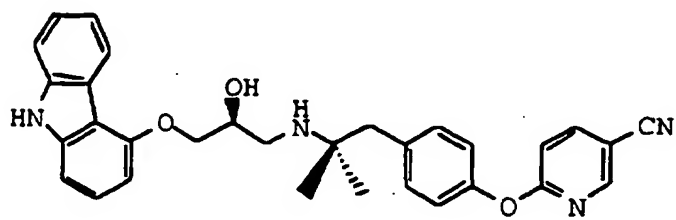
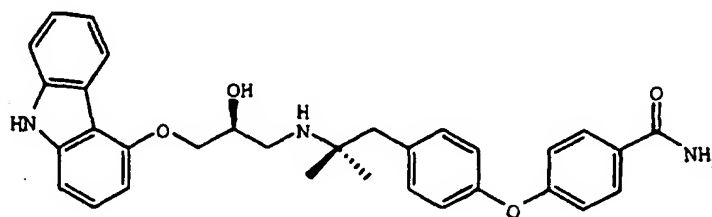
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(bk) R₇ is hydrogen(bl) R₇ is halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONR₂R₂, NHCOR₂, C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂.5 (bm) R₇ is halo, hydroxy, OR₂, C₁-C₄ alkyl, or C₁-C₄ alkoxy.

Especially preferred compounds include the following:

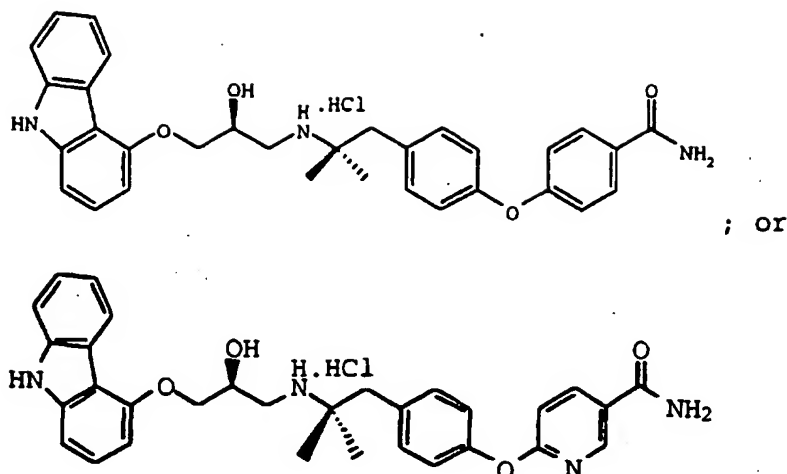


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5 By virtue of their acidic moieties, some of the compounds of Formula I include the pharmaceutically acceptable base addition salts thereof. Such salts include those derived from inorganic bases such as ammonium and alkali and alkaline earth metal hydroxides, carbonates, bicarbonates, and the like, as well as salts derived from

10 basic organic amines such as aliphatic and aromatic amines, aliphatic diamines, hydroxy alkamines, and the like. Such bases useful in preparing the salts of this invention thus include ammonium hydroxide, potassium carbonate, sodium

15 bicarbonate, calcium hydroxide, methylamine, diethylamine, ethylenediamine, cyclohexylamine, ethanolamine and the like.

Because of a basic moiety, some of the compounds of Formula I can also exist as pharmaceutically acceptable acid addition salts. Acids commonly employed to form such

20 salts include inorganic acids such as hydrochloric, hydrobromic, hydroiodic, sulfuric and phosphoric acid, as well as organic acids such as para-toluenesulfonic, methanesulfonic, oxalic, para-bromophenylsulfonic, carbonic, succinic, citric, benzoic, acetic acid, and

25 related inorganic and organic acids. Such pharmaceutically acceptable salts thus include sulfate, pyrosulfate, bisulfate, sulfite, bisulfite, phosphate, mono-hydrogenphosphate, dihydrogenphosphate, metaphosphate,

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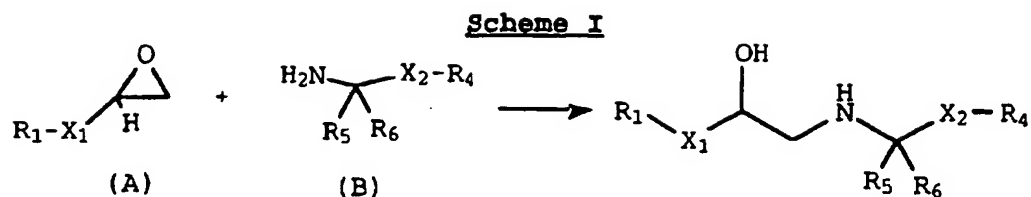
pyrophosphate, chloride, bromide, iodide, acetate, propionate, decanoate, caprylate, acrylate, formate, isobutyrate, heptanoate, propiolate, oxalate, malonate, succinate, suberate, sebacate, fumarate, maleate, 2-butyne-
5 1,4 dioate, 3-hexyne-2, 5-dioate, benzoate, chlorobenzoate, hydroxybenzoate, methoxybenzoate, phthalate, xylenesulfonate, phenylacetate, phenylpropionate, phenylbutyrate, citrate, lactate, hippurate, β -hydroxybutyrate, glycollate, maleate, tartrate,
10 methanesulfonate, propanesulfonate, naphthalene-1-sulfonate, naphthalene-2-sulfonate, mandelate and the like salts.

In addition, it is recognized that compounds of the present invention may for a variety of solvates with a number of different solvents. Representative solvates can
15 be useful as final embodiments of the present invention or as intermediates in the isolation or preparation of the final embodiments of this invention. For example solvates can be prepared with lower alcohols such as ethanol and with alkyl esters such ethylacetate.

20 It is recognized that various stereoisomeric forms of the compounds of Formula I may exist. The compounds may be prepared as racemates and can be conveniently used as such. Therefore, the racemates, individual enantiomers, diastereomers, or mixtures thereof form part of the present
25 invention. Unless otherwise specified, whenever a compound is described or referenced in this specification all the racemates, individual enantiomers, diastereomers, or mixtures thereof are included in said reference or description.

30 The compounds of Formula I can be prepared as described in the following Schemes and Examples. Schemes I and II describe methodology for the preparation of final embodiments of the present invention. Schemes III-VII
35 represent methodology for the preparation of intermediates required for the construction of the final embodiments of the invention.

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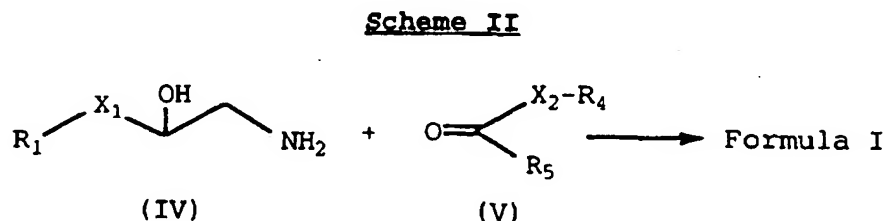


In Scheme I, X_1 , X_2 , R_1 , R_2 , R_4 , R_5 , and R_6 have the same meaning as previously described; and X_3 is a bond.

- 5 The reaction of Scheme I is carried out under conditions appreciated in the art for the amination of epoxides. For example, the epoxide (A) may be combined with the amine (B) in an alcohol, such as ethanol, at room temperature to the reflux temperature of the reaction mixture. Preferably, the
- 10 reaction is carried out under conditions generally described in Atkins et al., Tetrahedron Lett. 27:2451 (1986). These conditions include mixing the reagents in the presence of trimethylsilyl acetamide in a polar aprotic solvent such as acetonitrile, dimethylformamide (DMF), acetone,
- 15 dimethylsulfoxide (DMSO), dioxane, diethylene glycol dimethyl ether (diglyme), tetrahydrofuran (THF), or other polar aprotic solvents in which the reagents are soluble. Preferably, the solvent is DMSO. The reaction is carried out at temperatures ranging from about 0°C to reflux.

- 20 Expoxides utilized in scheme I can be prepared by methods well known in the art, or according to Scheme III from starting material known in the art.

- Certain compounds of the present invention are prepared by a novel combinatorial/parallel synthesis. This
- 25 synthesis is described in Scheme II.



- 30 In Scheme II, X_1 , X_2 , R_1 , R_4 , and R_5 have the same meaning as previously described and R_6 is hydrogen. The

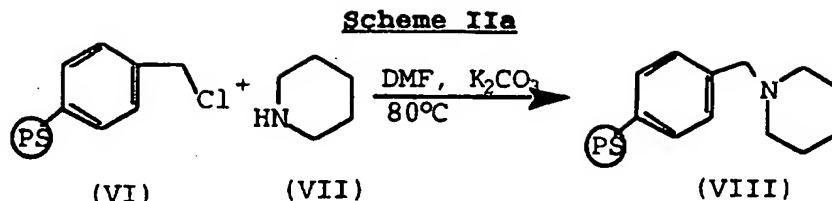
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reaction of Scheme II is preferably carried out by adding to a glass vial: a non-reactive solvent such as methanol, DMF, methylene chloride or acetonitrile, amine (IV), and ketone (V). The solution is shaken to allow for imine formation and treated with Amberlite IRA400 borohydride resin (Aldrich Chemicals). The slurry is then shaken an additional 24 hours to effect reduction to the secondary amine. Methylene chloride and polystyrene-linked benzaldehyde resin (Frechet, J.M. et al., J. Am Chem. Soc. 93:492 (1971)) is added to the vial, in order to scavenge excess primary amine starting material. The slurry is shaken, preferably overnight. The slurry is then filtered through a cotton plug, and the residual solids are rinsed with methanol. Evaporation under a flow of air, followed by drying for several hours at room temperature in a vacuum oven yields the desired product of sufficient purity.

Alternatively, compounds of formula (V) can be prepared by dissolving, in a vial, the amine and ketone in a non-reactive solvent or solvent mixture such as methanol, DMF, or the like. Acetic acid and sodium cyanoborohydride are then added. After being shaken for approximately 72 hours the reaction mixture is applied to an ionexchange column such as SCX. The column is flushed with solvent and the product was then eluted using a solution such as ammonia in methanol. The solvent was evaporated, followed by drying in a vacuum oven to yield the secondary amine product.

A modification of Scheme II is necessary when the amine hydrochloride salt is used. Addition of resin-bound base to the initial reaction mixture prior to reduction or scavenging allows the desired reaction to proceed. Imine formation using amine hydrochloride salts, an aldehyde or ketone, and a resin bound amine base may be carried out using two different resins: poly(4-vinylpyridine), commercially available from Aldrich, and resin (VIII), synthesized by the reaction of Merrifield resin with piperidine (Scheme IIa):

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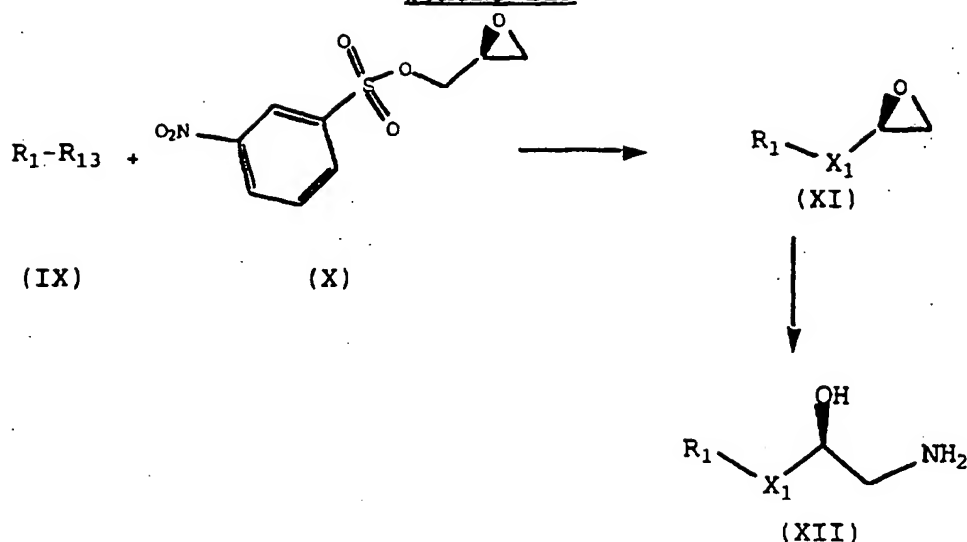


In Scheme IIa, PS is polystyrene. Both the poly(4-vinylpyridine) and resin (VIII) promote imine formation.

Scheme II can also be carried out by utilization of traditional techniques. Reductive aminations described in scheme II are well known in the art. They are typically performed by mixing the amine and ketone starting materials in a solvent and adding a reducing agent. Solvents typically include lower alcohols, DMF, and the like. A wide variety of reducing agents can be utilized, most commonly utilized are sodium borohydride and sodium cyanoborohydride. The reaction is typically performed at room temperature to the reflux temperature of the solvent. Products are isolated by techniques well known in the art.

The ketone and amino starting materials of Scheme II can be prepared by techniques recognized and appreciated by one skilled in the art. The synthesis of the starting materials is generally described in Schemes III and VII.

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Scheme III

- In Scheme III, R_1 is the same as previously defined. R_{13} is OH or SH. Equimolar amounts of the aromatic compound (Compound IX) and (2S)-(+)-glycidyl 3-nitrobenzenesulfonate (Compound X) are dissolved in an inert solvent such as acetone or DMF and treated with about 1.1 equivalents of a non-reactive acid scavenger, such as K_2CO_3 . The suspension is then heated at reflux for 16-20 hours with stirring. The solvent is removed in vacuo. The residue is partitioned between chloroform or other organic solvent and water. The organic layer is dried over Na_2SO_4 and concentrated in vacuo to give the compound (XI) in sufficient purity (>95%) and yield (85-100%).

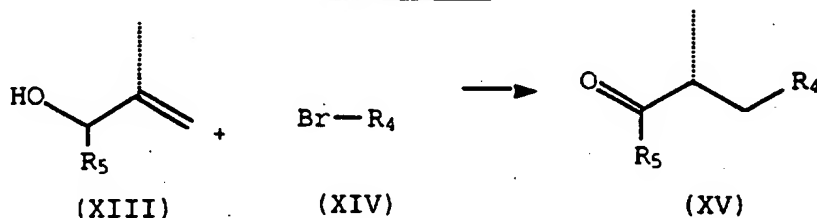
- The epoxide (XI) is dissolved in an alcohol, preferably methanol, and treated with one equivalent of dibenzylamine. The solution is preferably stirred at reflux for three to four hours and then cooled to ambient temperature. Approximately 10 equivalents of ammonium formate are added to the flask, followed by 10% palladium on carbon, and the suspension stirred vigorously at reflux for 30-45 minutes. The reaction mixture is then filtered through Celite, concentrated in vacuo to a minimum volume and treated with 1.1 equivalents of a 1.0 M anhydrous

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solution of HCl in ether. The solution is concentrated to dryness. The solid residue is triturated with pentane to yield products of sufficient purity (>97%) and yield (60-100%). If desired, further purification may be carried out by passing over a short plug of silica, eluting with CHCl₃, then 95:5 CHCl₃/MeOH, then 25:5:1 CHCl₃/MeOH/NH₄OH.

Alternatively, the epoxide (XI) is treated with a solution of methanol saturated with ammonia gas and stirred at room temperature in a sealed tube for 16 hours. This solution is then evaporated, and the residue subjected to standard purifications such as column chromatography or recrystallization. The HCl salt is then optionally produced by the addition of HCl gas in ether.

The ketone moieties of Scheme II, that are either unknown in the art or not commercially available, can be prepared in accordance with Scheme IV.

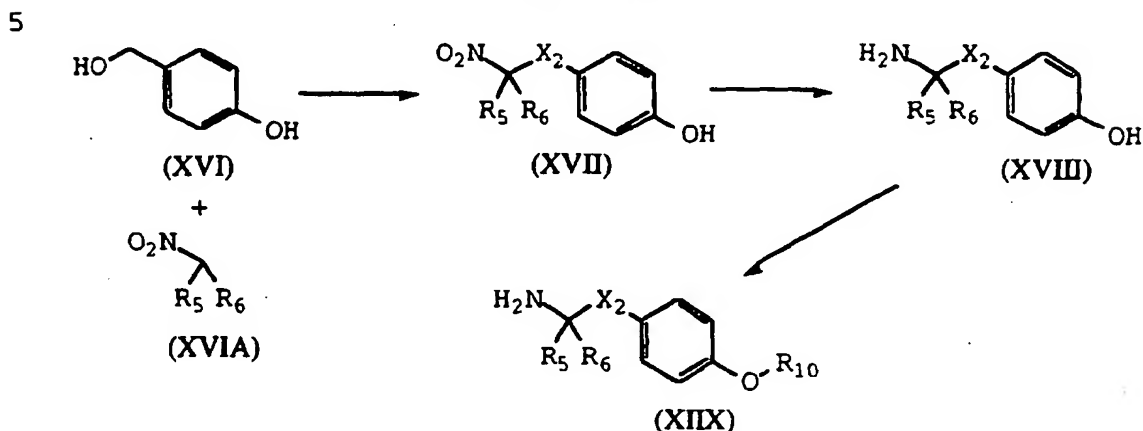
Scheme IV

In Scheme IV, R₄ and R₅ are the same as previously defined. The notation ---- indicates optional branching. Preferably, R₄ is a substituted phenyl. The reaction described in Scheme IV is referred to as a Heck reaction and is described in A.J. Chalk et al., J. Org. Chem. **41**: 1206 (1976). The reaction is achieved by treating compound (XIII) with an arylpalladium reagent. The arylpalladium reagent is generated in situ by treating Compound (XIV) with a palladium-triarylphosphine complex. The reaction is generally carried out under conditions appreciated in the art.

Additional amines, of the type where X₂ is methylene, R₄ is aryl, and R₁₀ is aryl, heterocycle,

optionally substituted aryl, or optionally substituted heterocycle, that are reacted in a manner analogous to Scheme I can be prepared in accordance with Scheme V.

Scheme V



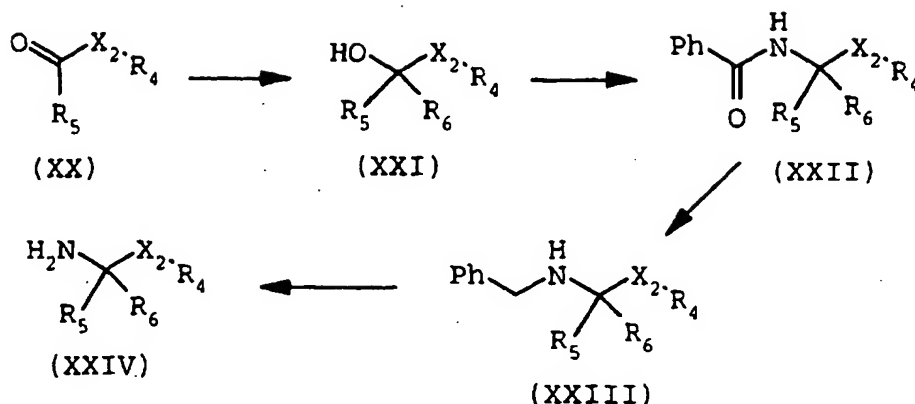
R_5 , R_6 , and R_{10} are as previously defined and X_2 is methylene. Compounds of the formula (XVII) can be prepared by reacting 4-hydroxybenzyl alcohol with excess (5 mol/equiv) of a compound of formula (XVIIA) by methods well known in the art. (see Sh. Prikl. Kin., Vol 45, 1573-77 (1972); Russ.) The reaction can also be carried out by mixing the reagents in an aprotic solvent, preferably diglyme, and adding potassium *t*-butoxide (0.5 mol/equiv.). The reaction is then heated to reflux and water removed. After removal of water is complete, generally 2-8 hours depending upon the scale of the reaction, the resulting solution is subjected to aqueous workup including acidic washes and the product is isolated by crystallization. Compound (XVII) can be reduced by methods well known in the art. Compound (XVIII) is preferably prepared by hydrogenation of the corresponding compound (XVII) over a precious metal catalyst. The hydrogenation can be affected at between 20 and 60 psi of hydrogen, and with a variety of solvents, temperatures, and catalysts well known in the art. The reaction is preferably carried out at 50 psi of hydrogen over 5% palladium on carbon wetted with 2B3 ethanol.

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Compound (XVII) is charged to the reactor along with one equivalent of acetic acid, diluted with methanol, heated to 50°C, and subjected to hydrogen for 5-24 hours depending on the scale of the reaction. The product is isolated as the acetic acid salt upon work up by methods well known in the art.

A skilled artisan would appreciate that compound (XVIII) could be coupled with a wide variety of aromatic halides to yield the claimed ethers. The coupling can be carried out according to procedures well known in the art and is preferably performed by mixing the starting materials in N,N-dimethylacetamide and toluene in the presence of potassium carbonate. The reaction is then heated to reflux for 5 to 24 hours and water removed. The product is typically isolated by aqueous work up after rotory evaporation of the reaction solvent. The crude product can be purified by methods well know in the art. A skilled artisan would appreciate that the amines prepared by Scheme V can be utilized in Scheme I to prepare compounds of the present invention.

Other amines used to construct final embodiments of the present invention can be prepared according to scheme VI.

Scheme VI

5 Compounds of formula (XXI) can be prepared by the addition of a nucleophile, of the formula $\text{R}_6\text{-M}$, wherein M is a metal or metal salt, to the compounds of formula (XX) according to procedures well known in the art. The skilled artisan would appreciate a wide variety of conditions amenable to performing the additions. Preferred

10 nucleophiles include, but are not intended to be limited to, alkyl grignard reagents, alkyl lithium reagents, and the like.

15 Compounds of formula (XXII) can be prepared from the compounds of formula (XXI) by the Ritter reaction. (See *Organic Reactions*, Vol. 17, pp. 213-325, (1979)).

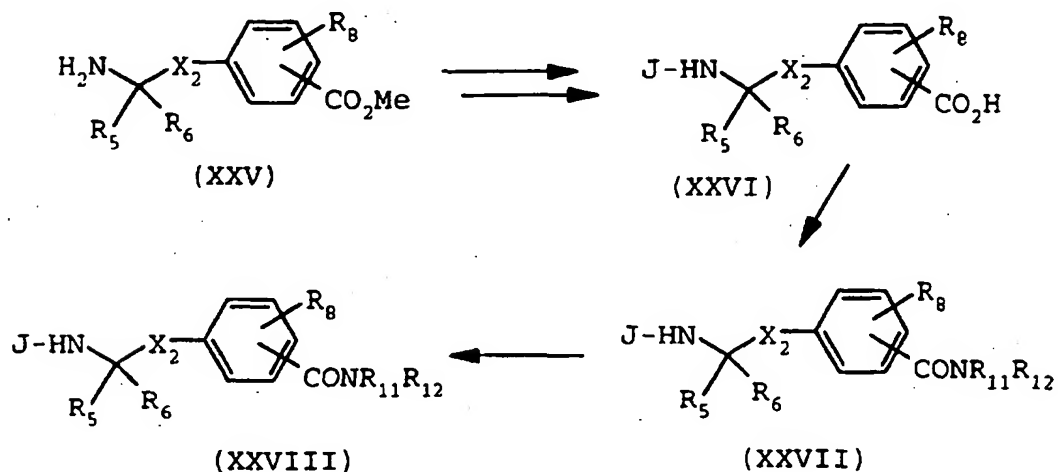
20 Compounds of formula (XXIII) can be prepared by reduction of the compounds of formula (XXII) according to procedures well known in the art. Preferred reducing agents include, but are not intended to be limited to, borane complexes and the like.

25 Compounds of formula (XXIV) can be prepared by reduction of the compounds of formula (XXIII) according to procedures well known in the art. (See Greene T. W., *Protective Groups in Organic Synthesis*, John Wiley and Sons, (1981)).

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Other amines used to construct final embodiments of the present invention can be prepared according to scheme VII, wherein J is a protecting group.

5

Scheme VII

The compounds of formula (XXVI) can be prepared from the amino esters of formula (XXV) by methods well known in the art. (see, Greene *supra*).

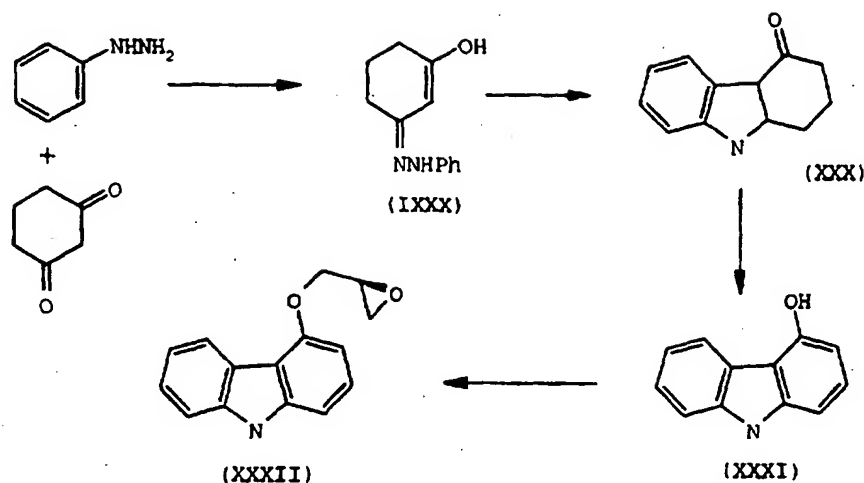
The amides of formula (XXVII) can be prepared from the N-protected amino acids of formula (XXVI) by methods well known in the art. For example, any number of peptide coupling procedures will affect the desired reaction. (see March, *Advanced Organic Chemistry*, 3 ed.)

The deprotection of the compounds of formula (XXVII) can be accomplished by methods well known in the art. (see, Greene *supra*).

20

SCHEME VIII

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Compound (IXXX) can be prepared by the addition of phenyl hydrazine to 1,3-cyclohexanedione by methods known in the art. For example, phenylhydrazine or its salt can be dissolved in water and cyclohexanedione added. The addition is preferably carried out in a dropwise fashion at room temperature. Other methods of addition and temperatures, however, would be operable. After stirring for 4-24 hours, the resulting precipitate can be collected by filtration and purified by methods known in the art.

Compound (XXX) can be prepared by the cyclization of compounds of formula (IXXX) by methods known in the art. For example, the transformation can be affected by heating the compound of formula (IXXX) in the presence of an acid such as phosphoric acid, sulfuric acid, trifluoroacetic acid, and the like. While the reaction can be affected at lower temperatures, the reaction is preferably performed at about 90°C, for about 1-2 hours, in neat phosphoric acid.

Dehydrogenation of the compound of formula (XXX) to yield 4-hydroxycarbazole can be accomplished by methods well known in the art. For example, the compound of formula (XXX) can be reacted with Raney-nickel, copper bromide, or palladium on carbon. The preferred conditions include stirring with 5% or 10% palladium on carbon in cymene and dodecene. The skilled artisan would appreciate that such a transformation can be performed at a range of temperatures, the progress of

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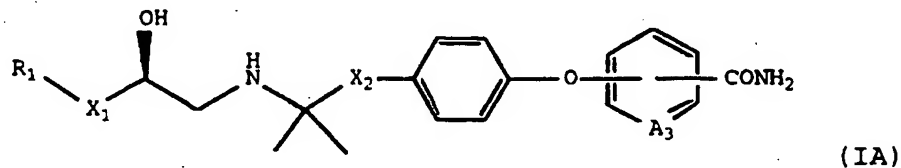
which is typically monitored by TLC or other analytical techniques.

Compound of formula (XXXII) can be prepared from 4-hydroxycarbazole by methods well known in the art. For example, equimolar amounts of the 4-hydroxycarbazole and (2S)-(+)-glycidyl 3-nitrobenzenesulfonate can be dissolved in an inert solvent such as acetone and treated with 1.1 equivalents of a non-reactive acid scavenger, such as potassium carbonate or cesium carbonate. The suspension is then heated at reflux for about 16-20 hours with stirring. The solvent can be removed in vacuo. The residue is partitioned between chloroform or other organic solvent and water. The organic layer can be dried over Na₂SO₄ and concentrated in vacuo to give the compound (XI) in sufficient purity (>95%) and yield (85-100%).

Alternatively, 4-hydroxycarbazole can be reacted with epichlorohydrin, by methods known in the art and the resulting product can be closed to the epoxide compound of formula (XXXII) by methods well known in the art.

Starting materials for the compounds described in Schemes I-VIII, as well as starting materials for the Preparations and Examples included herein, are either commercially available, known in the art, or can be prepared by methods known in the art or described herein.

Another embodiment of the present invention is a process of preparing novel compounds of the formula IA;



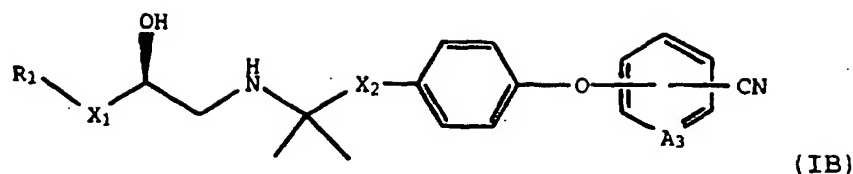
wherein:

A₃ is CH or N;

which comprises:

in step 1, hydrolysis of a compound of the formula IB;

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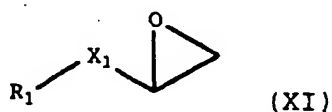


and, optionally, in step 2, reacting the product of step 1 with an acid to form an acid addition salt.

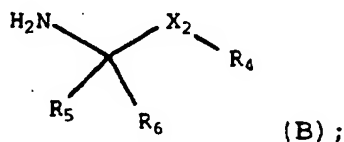
- 5 Step one of the process can be carried out by a variety of agents known in the art. It is, however, preferably affected by utilization of one of the following agents: polyphosphoric acid, H₂O₂ and K₂CO₃ in dimethylsulfoxide, H₂O₂ and ammonium hydroxide, H₂O₂ and
- 10 sodium hydroxide, potassium hydroxide and t-butanol, or water and mineral or organic acid. Step 2 of the process involves addition of an agent capable of forming an acid addition salt with the product of step 1. Step 2 can be carried out by numerous methods known in the art involving
- 15 addition of mineral acid, or other acid, to a solution of the product of step 1. Additionally, the product of step one could be purified prior to step 2 and the present invention contemplates such an optional purification step.

- Another embodiment of the present invention is a
- 20 process of preparing a compound of Formula I which comprises:

In step 1, reacting an epoxide of the formula XI:



- 25 with an amine of formula (B):



and optionally in step 2, reacting the product of step 1 with an acid to form an acid addition salt.

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The process can be carried out by a variety of agents known in the art or described herein, it is however preferably affected by reacting the amine and epoxide in a solvent at elevated temperature. Preferred solvents include: lower alcohols, dimethylformamide, dimethylsulfoxide, acetone and the like. The reaction is generally performed at a temperature ranging from ambient to the reflux temperature of the solvent. Most preferably, it is done in ethanol at 40-60°C. Step 2 can be carried out by numerous methods known in the art involving addition of mineral acid, or other acid, to a solution of the product of step 1. Additionally, the product of step one could be purified prior to step 2 and the present invention contemplates such an optional purification step.

Preparations and Examples

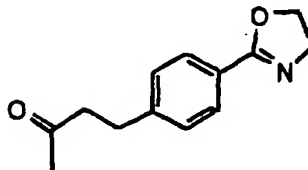
The following examples and preparations are provided merely to further illustrate the invention. The scope of the invention is not construed as merely consisting of the following examples. In the following examples and preparations, melting point, nuclear magnetic resonance spectra, mass spectra, high pressure liquid chromatography over silica gel, gas chromatography, N,N-dimethylformamide, palladium on charcoal, tetrahydrofuran, ethyl acetate, thin layer chromatography and elemental analysis are abbreviated M.Pt., NMR, MS, HPLC, GC, DMF, Pd/C, THF, EtOAc, TLC and EA respectively. The terms "EA", "TLC", "NMR", and "MS", when being utilized in the preparations, indicate that the data indicated was consistent with the desired structure.

Preparations 1 through 24 describe syntheses of compounds utilized in combinatorial scheme II.

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Preparation 1

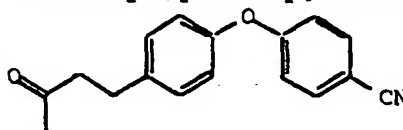
4-(3-Oxobutyl)-1-(2-oxazolidinyl)benzene



5 4-Bromo-1-(2-oxazolidine)benzene (3.0 g, 13.3 mmol), 3-buten-2-ol (1.4 g, 20 mmol), Pd(OAc)₂ (60 mg, 0.26 mmol), (o-tolyl)₃P (158 mg, 0.52 mmol), sodium bicarbonate (1.34 g, 15.9 mmol) in 30 mL of N-methylpyrrolidinone were heated under nitrogen at 130°C for 1 hour. The reaction mixture
10 was then cooled and partitioned between ethyl acetate and water. The combined organic layers were washed with water and then dried (Na₂SO₄), filtered, and concentrated in vacuo to yield 2.6 g of a tan oil. Purification by flash chromatography (silica gel, 1:1 ethyl acetate/hexane)
15 yielded 1.9 g of a pale yellow oil which crystallized upon drying under vacuum. Recrystallization from hexane gave 1.47 g (49%) of white needles, m.p. 62-64°C. NMR. MS.

Preparation 2

4-[4-(3-Oxobutyl)phenoxy]benzonitrile

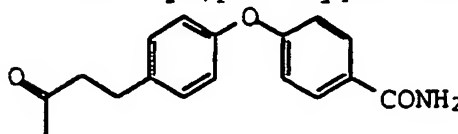


20 4-Fluorobenzonitrile (6.05 g, 50mmol), 4-(4-hydroxyphenyl)-2-butanone (8.21 g, 50mmol) and potassium carbonate (8.3 g, 60mmol) were dissolved in N,N-dimethylacetamide (50 mL) and heated at 150°C for 4 hours
25 under nitrogen. The reaction mixture was then poured into 800 mL of ice water. A slowly crystallizing solid was filtered to give 13 g of crude product. This material was recrystallized from ethanol/water (3:1) to give 10.48 g (79%) of pale brown crystals, m.p. 64-66°C. EA. NMR. MS.

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Preparation 3

[4-(3-Oxobutyl)phenoxy]benzamide



4-[4-(3-Oxobutyl)phenoxy]benzonitrile (6.0 g, 22.6mmol)
5 and potassium carbonate (1.0 g, 7.2mmol) were slurried in
DMSO (50mL) and cooled to 0°C in an ice bath. Aqueous 30%
hydrogen peroxide (6 mL) was added slowly, and the mixture
stirred at 0°C for 1 hour. The reaction was quenched by
pouring into 500 mL water, and the subsequent white
10 precipitate was collected and washed with water. This
material was recrystallized from 300 mL ethanol to give 5.35
g (84%) white crystals, m.p. 169-172°C. NMR. MS. EA.

Preparation 4

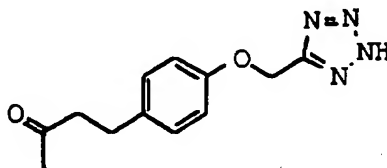
2-Triphenylmethyl-5-chloromethyltetrazole

15 5-Chloromethyltetrazole (1.19 g, 10 mmol) in CH₂Cl₂ (10
mL) was treated with triphenylmethyl chloride (2.79 g, 10
mmol) and diisopropylethylamine (2.0 mL, 11.5 mmol) and
stirred for 40 minutes at room temperature. The reaction
mixture was concentrated in vacuo and partitioned between
20 ethyl acetate/water. The organic layer was washed with
saturated NaHCO₃ solution, then brine, dried (Na₂SO₄) and
concentrated in vacuo to yield 3.48 g of an off-white solid.
Trituration of this residue in diethyl ether yielded 3.04 g
(84%) of a white solid, m.p.162-165°C. NMR. MS. EA.

25

Preparation 5

5-[4-(2-Oxobutyl)phenoxy]methyl]tetrazole



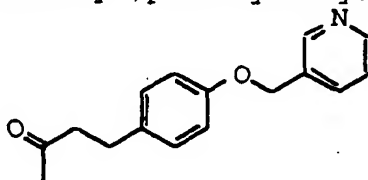
4-(4-Hydroxyphenyl)-2-butanone (493 mg, 3 mmol) was
30 cooled to 5°C and treated with NaH (180 mg, 4.5 mmol, 60% in
mineral oil) under nitrogen. After 15 minutes the ice bath

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was removed and the solution allowed to warm to room temperature over 45 minutes. The reaction was cooled to 5°C and treated with 2-triphenylmethyl-5-chloromethyltetrazole (1.08 g, 3 mmol) and stirred at room temperature for 3
5 hours. The reaction mixture was poured into EtOAc (300 mL), and washed with water then brine. The organic layer was dried (MgSO₄) and concentrated in vacuo to provide a yellow solid. This material was suspended in a mixture of MeOH (100 mL) and THF (50 mL) and treated with 4N HCl in dioxane
10 (7.5 mL, 30 mmol). The resulting mixture was stirred for 1.5 hr. and then concentrated in vacuo to provide a tan solid. The residue was applied to a silica chromatography column and eluted with 33-100% ethyl acetate in hexane to provide 235 mg (32%) of a white solid, m.p. 148-150°C. NMR.
15 MS. EA.

Preparation 6

3-[4-(2-Oxobutyl)phenoxy]methylpyridine



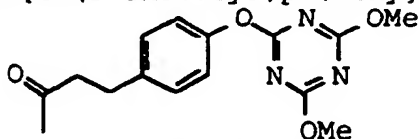
4-(4-Hydroxyphenyl)-2-butanone (4.11 g, 25 mmol) and
20 potassium carbonate (10.37 g, 75 mmol) in acetone (30 mL) was treated with 3-picoly chloride hydrochloride (4.27 g, 26 mmol) under nitrogen. The mixture was stirred at reflux for 21 hours, proceeding about 50% towards completion. Potassium iodide (2.0 g, 13 mmol, 0.5 eq) was added and
25 after 3 hours no picolyl chloride was observed on TLC. The volatiles were removed in vacuo and the resulting residue partitioned between EtOAc/water. The combined organic layers were washed with water, saturated NaHCO₃ solution, 10% Na₂SO₃, and then brine. The organic layer was dried
30 (MgSO₄) and concentrated in vacuo to provide 4.8 g of a yellow oil. The material was purified on a Waters Prep 2000LC by elution with 10-80% ethyl acetate in hexanes over

-35-

45 minutes to yield 2.20 g (34%) of an oil which solidified on standing, m.p. 35-37°C. NMR. MS. EA.

Preparation 7

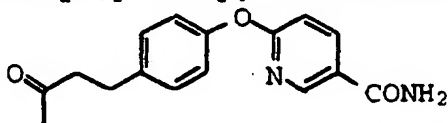
2,6-Dimethoxy-4-[4-(2-oxobutyl)phenoxy]-1,3,5-triazine



5 4-(4-Hydroxyphenyl)-2-butanone (4.93 g, 30 mmol) was added to a solution of sodium methoxide (1.62 g, 30 mmol) in methanol (150 mL) under nitrogen. After stirring for 1 hour the methanol was removed in vacuo and the residue suspended
10 in acetone (200 mL). The suspension was treated with 4,6-dimethoxy-2-chlorotriazine and refluxed for 3 hours. The volatiles were removed in vacuo and the residue partitioned between ethyl acetate/water. The organic layers were dried (MgSO₄) and concentrated in vacuo to provide 10.28 g of a
15 white semi-solid. The material was purified on a Waters Prep 2000LC by elution with a gradient of 20-60% ethyl acetate in hexanes over 55 minutes to yield 4.43 g (49%) of a colorless oil. NMR. MS. EA.

Preparation 8

20 2-[4-(2-Oxobutyl)phenoxy]-5-carboxamidopyridine



4-(4-Hydroxyphenyl)-2-butanone (3.28 g, 20 mmol) in anhydrous DMF (150 mL) was treated with NaH (1.2 g, 30 mmol, 60% in mineral oil) under nitrogen. The solution was
25 stirred for 30 minutes at ambient temperature and then treated with 6-chloronicotinamide (3.13 g, 20 mmol). The reaction was stirred at 60°C for 1.5 hours and then 90°C for five hours. The reaction was allowed to cool, poured into 50% saturated ammonium chloride solution, and extracted with
30 EtOAc. The organic layer was dried (MgSO₄) and concentrated in vacuo with a xylene azeotrope to yield 11.4 g of a brown oil. The material was purified on a Waters Prep 2000LC by

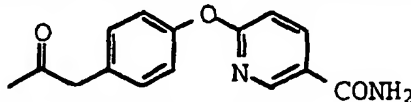
-36-

elution with 75-100% EtOAc over 60 minutes. The resulting material was triturated in cold EtOAc and collected by filtration to provide 2.73 g (48%) white solid m.p. 137-139°C. EA. NMR. MS.

5

Preparation 9

2-[4-(2-Oxopropyl)phenoxy]-5-carboxamidopyridine

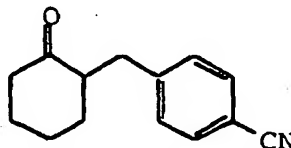


In a manner similar to the above examples, 3-(4-hydroxyphenyl)-2-propanone (2.25 g, 15 mmol) was treated with NaH (0.9 g, 22.5 mmol, 60% in mineral oil) followed by reaction with 6-chloronicotinamide (2.34 g, 15 mmol). Following workup the material was purified on a Waters Prep 2000LC to provide 1.28 g (32%) of a light yellow solid. m.p. 172-174°C. NMR. MS. EA.

15

Preparation 10

{4-[(2-Oxocyclohexyl)methyl]benzonitrile



A mixture of methyl cyclohexanone-2-carboxylate (11.0 g, 70 mmol, from Fluka), α -bromo-p-tolunitrile (12.3 g, 63 mmol), potassium carbonate (10.5 g, 76 mmol) in THF (200 mL) was refluxed for 24 hours. The progress of the reaction was followed by GC. The reaction was diluted with water and the THF was removed under reduced pressure. The aqueous portion was extracted with EtOAc, dried (MgSO₄), and concentrated to give 19.3 g of a white solid that was 74% pure by gas chromatography. The solid was recrystallized from hexane/EtOAc to give 7.75 g white crystals that were 100% pure by glc. A second crop of 3.65 g was obtained by adding more hexane to the filtrate. Overall, 11.4 g (67%) of 1-[(4-cyanophenyl)methyl]-1-methoxycarbonyl-2-oxocyclohexane carboxylate, was obtained; mp 82-84°C. NMR. MS.

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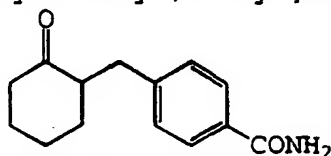
Under a blanket of nitrogen, a mixture of 1-[(4-cyanophenyl)methyl]-1-methoxycarbonyl-2-oxocyclohexane carboxylate (7.6 g, 28 mmol), sodium cyanide (2.1 g, 42 mmol) and DMSO (100 mL) was heated at 115°C for 1.5 hours.

5 The progress of the reaction was monitored by glc. The reaction was cooled and partitioned between water, EtOAc and brine. The organic layer was washed with water and dried (MgSO₄). After concentration, crude product was obtained as a tan oil. Purification by plug filtration (200 g silica

10 gel, 15% EtOAc/hexane) gave 3.3 g (55%) product as colorless oil. NMR. MS.

Preparation 11

[(2-Oxocyclohexyl)methyl]benzamide



15 A DMSO (20 mL) solution of the compound of Preparation 28 (2.5 g, 11.7 mmol) was cooled in an ice bath. Solid K₂CO₃ (500 mg) was added followed immediately by 30% H₂O₂ (3 mL). After 20 minutes, TLC (3/7 EtOAc/hexane)

20 showed a trace of starting material remained. The ice bath was removed and the reaction was stirred and room temperature for 1 hour. The reaction was diluted with 500 mL water and the white solid collected and dried to give 2.44 g (90%) desired amide. The product was recrystallized from 1/9 EtOAc/hexane to give 2.02 g of the titled product

25 as white crystals, mp 167-170°C. NMR. MS.

Preparation 12

Tetralone-6-carboxylic acid, ethylene ketal

6-Bromo-2-tetralone (2.0 g, 8.89 mmol) was dissolved in toluene (50 mL) and treated with excess

30 ethylene glycol (4.88 mL, 88.9 mmol) and catalytic p-toluenesulfonic acid (15 mg). The solution was stirred at reflux 16 hours, and water was removed from the reaction mixture using a Dean-Stark condenser. After cooling to

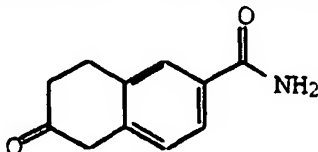
-38-

ambient temperature, the toluene solution was washed 2 x 1N NaOH; 1 x water, 1 x brine, dried over Na₂SO₄ and concentrated in vacuo to give 2.23 g (93%) of 6-bromo-2-tetralone ethylene ketal as a brown oil which was used without further purification.

6-Bromo-2-tetralone ethylene ketal (2.2 g, 8.15 mmol) was dissolved in anhydrous THF (30 mL), cooled to -78°C and treated with tert-butyllithium (12.05 mL, 20.4 mmol, 1.7M in pentane) under an atmosphere of nitrogen. After stirring for 30 minutes, anhydrous carbon dioxide gas was passed through the reaction mixture for 20 minutes at -78°C. The suspension was then allowed to warm to ambient temperature. The solution was quenched with water and acidified with 1N HCl, then extracted 2 x EtOAc. The organic extracts were washed with brine, dried over Na₂SO₄ and concentrated in vacuo to a pale brown oil. The oily residue was applied to a silica flash chromatography column and eluted with 30%-50% EtOAc in hexanes to yield tetralone-6-carboxylic acid, ethylene ketal 1.06 g (55%) of a slowly crystallizing solid. NMR. MS.

Preparation 13

Tetralone-6-carboxamide



Tetralone-6-carboxylic acid, ethylene ketal (395 mg, 2.07 mmol) was codissolved in CH₂Cl₂ (50 mL) with N-hydroxysuccinimide (260 mg, 2.76 mmol) at 0°C and treated with a slight excess of 1,3-dicyclohexylcarbodiimide (502 mg, 2.50 mmol). The mixture was allowed to warm to ambient temperature over 30 minutes, during which time a fine white precipitate formed. Ammonium chloride (333 mg, 6.23 mmol) and triethylamine (1.58 mL, 12.5 mmol, d=0.797) were added. The solution was stirred at ambient temperature for 16 hours. The suspended urea and salts were filtered away and the solution concentrated in vacuo to a colorless oil. The

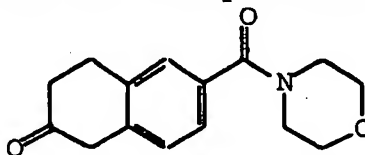
-39-

oil was applied to a silica flash chromatography column and eluted with 50-100% EtOAc in hexanes to yield 250 mg (64%) of 2-tetralone-6-carboxamide, ethylene ketal as a white solid, clean by NMR, TLC.

- 5 2-Tetralone-6-carboxamide ethylene ketal (250 mg, 1.07 mmol) and catalytic *p*-toluenesulfonic acid were stirred in acetone (50 mL) at ambient temperature for 48 hours. The volatiles were removed in vacuo and the residue triturated in ethyl acetate. The solids were filtered, washed and
10 dried to yield 77.5 mg (38%) of 2-tetralone-6-carboxamide as a white powder, pure by NMR, TLC. MS.

Preparation 14

Tetralone-6-morpholinamide

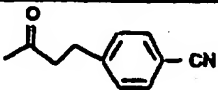
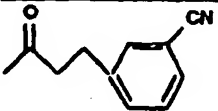
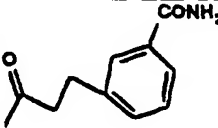
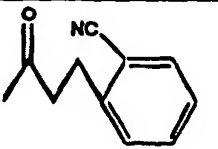
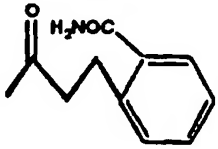
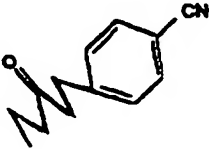


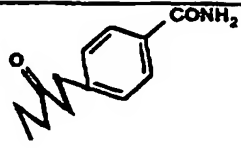
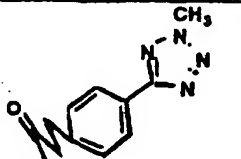
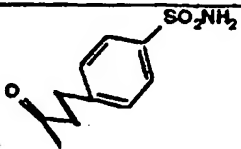
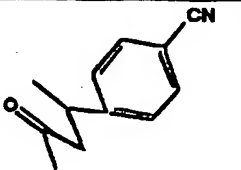
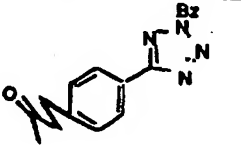
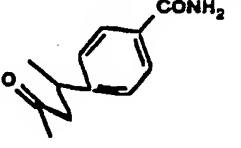
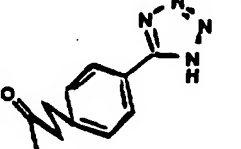
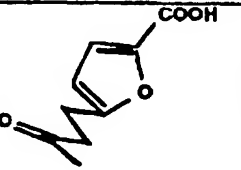
- 15 2-Tetralone-6-carboxylic acid, ethylene ketal (395 mg, 2.07 mmol) was co-dissolved in CH₂Cl₂ (50 mL) with *N*-hydroxysuccinimide (260 mg, 2.76 mmol) at 0°C and treated with a slight excess of 1,3-dicyclohexylcarbodiimide (502 mg, 2.50 mmol). The mixture was allowed to warm to ambient
20 temperature over 30 minutes, during which time a fine white precipitate formed. Morpholine (0.91 mL, 10.4 mmol, *d*=0.998) was added and the solution stirred at ambient temperature for 16 hours. The suspended urea was filtered away and the solution concentrated in vacuo to a colorless
25 oil. The oil was applied to a silica flash chromatography column and eluted with 50-100% EtOAc in hexanes to yield 323 mg (51%) of 2-tetralone-6-morpholinamide, ethylene ketal as a slowly crystallizing solid, clean by NMR, TLC.



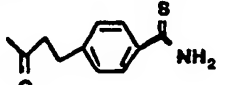
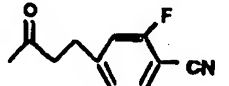
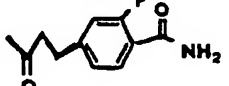
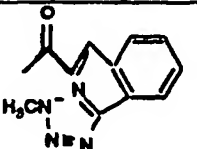
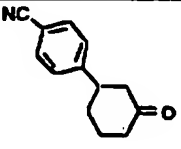
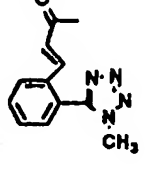
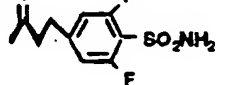
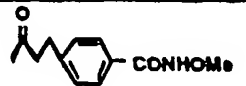
- 2-Tetralone-6-morpholinamide, ethylene ketal (323
30 mg, 1.06 mmol) and catalytic *p*-toluenesulfonic acid were stirred in acetone (50 mL) at ambient temperature for 48 hours. TLC indicated a mixture of 2-tetralone-6-morpholinamide, ethylene ketal and desired product, so the solution was heated to reflux for 16 hours. The volatiles

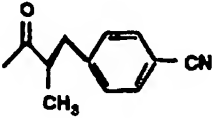
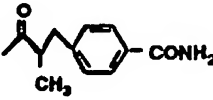
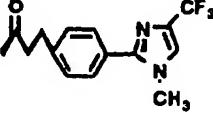
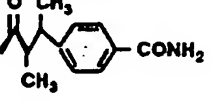
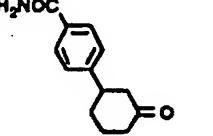
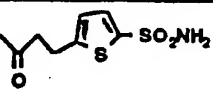
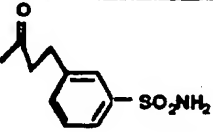
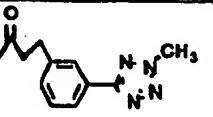
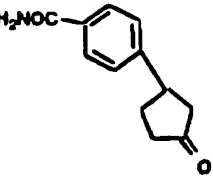
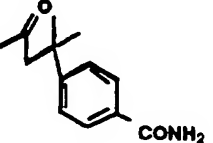
were removed in vacuo and the residue applied to a silica flash chromatography column and eluted with 50-100% EtOAc in hexanes to yield 27 mg (10%) of 2-tetralone-6-morpholinamide a slowly crystallizing solid, pure by NMR, TLC. MS.

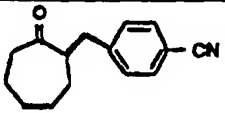
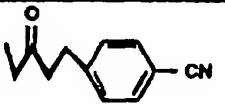
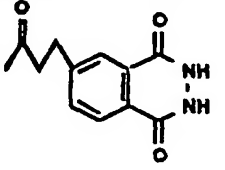
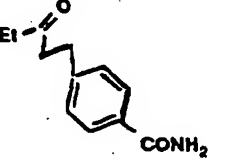
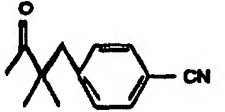
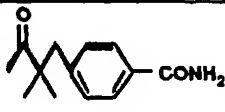
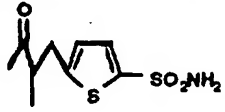
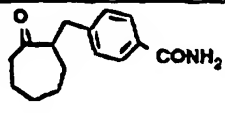
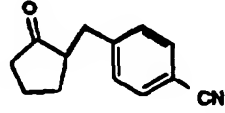
- 5 The following compounds were prepared in a manner analogous to schemes IV and/or preparations 1 through 14 described herein or by techniques appreciated in the art:

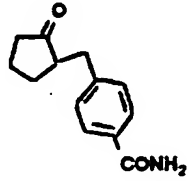
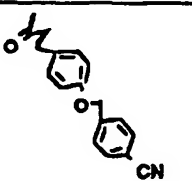
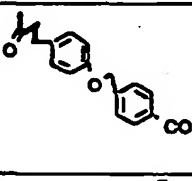
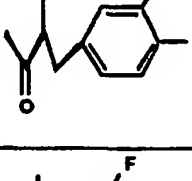
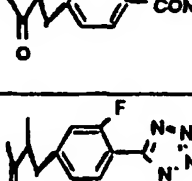
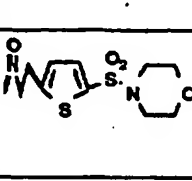
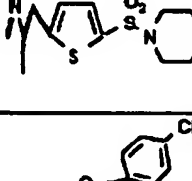
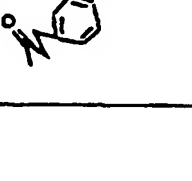

Name	Structure	m.p.	Yld	Data	
				NMR	MS
4-(3-oxobutyl) benzonitrile Preparation 15		oil	33%	x	x
3-(3-oxobutyl) benzonitrile Preparation 16		oil	44%	x	x
3-(3-oxobutyl) benzamide Preparation 17		104-6	45%	x	x
2-(3-oxobutyl) benzonitrile Preparation 18		oil	43%	x	x
(2-(3-oxobutyl) benzamide Preparation 19		113-114	91%	x	x
4-(3-oxohexyl) benzonitrile Preparation 20		oil	85%	x	x

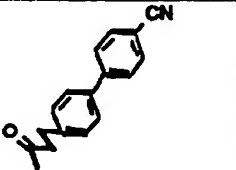
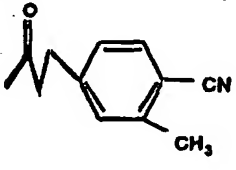
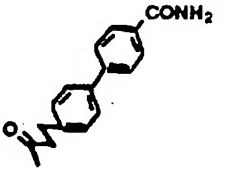
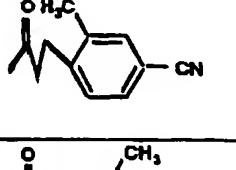
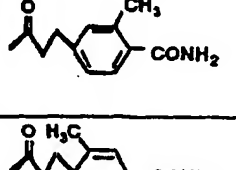
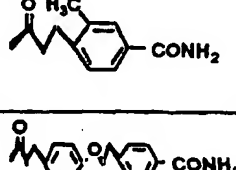
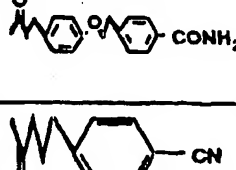
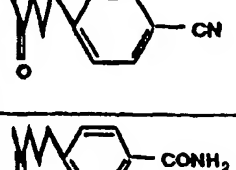
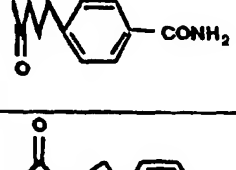
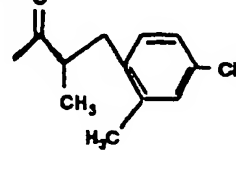
4-(3-oxohexyl)benzamide Preparation 21		90-93	67%	x	x
3-methyl-5-(4-(3-oxobutyl)phenyl)-1H-tetrazole Preparation 22		90-93	67%	x	x
(4-(3-oxobutyl)phenyl)sulfonamide Preparation 23		132-4	36%	x	x
4-(1-methyl-3-oxobutyl)benzonitrile Preparation 24		oil	44%	x	x
3-benzyl-5-(4-(3-oxobutyl)phenyl)-1H-tetrazole Preparation 25		66-9	41%	x	x
4-(1-methyl-3-oxobutyl)benzamide Preparation 26		127-9	95%	x	x
5-(4-(3-oxobutenyl)phenyl)-1H-tetrazole Preparation 27		197-9	94%	x	x
5-(3-oxobutyl)-2-furanoic acid Preparation 28		129-32	86%	x	x

3-(2-fluoro-4-(3-oxobutyl)phenyl)propenoic acid Preparation 29		143-6	95%	x	x
4-(3-oxobutyl)-1-cyanomethylbenzene Preparation 30		oil	100%	x	x
(4-(3-oxobutyl)phenyl)thioamide Preparation 31		96-8	low*	x	x
(2-fluoro-4-(3-oxobutyl)benzonitrile Preparation 32		oil	78%	x	x
2-fluoro-4-(3-oxobutyl)benzamide Preparation 33		150-3	85%	x	x
3-methyl-5-(2-(3-oxobutyl)phenyl)-1H-tetrazole Preparation 34		64-5	45%	x	x
4-(3-oxocyclohexyl)benzonitrile Preparation 35		66-69	36%	x	x
1-methyl-5-(2-(3-oxobutenyl)phenyl)-1H-tetrazole Preparation 36		100-102	18%	x	x
(2,6-difluoro-4-(3-oxobutyl)phenyl)sulfonamide Preparation 37		oil	41%	x	x
N-methoxyl-4-(3-oxobutyl)benzamide Preparation 38			low	x	x

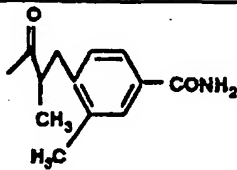
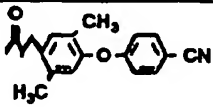
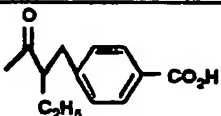
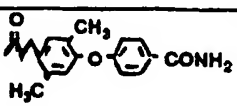
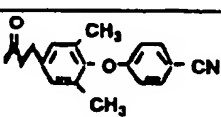
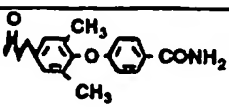
4-(2-methyl-3-oxobutyl)benzonitrile Preparation 39		oil	66%	x	x
4-(2-methyl-3-oxobutyl)benzamide Preparation 40		112-115	87%	x	x
(1-methyl-2-(4-(3-oxobutyl)phenyl)-4-trifluoromethyl)imidazole Preparation 41		62-3	68%	x	x
4-(1,2-dimethyl-3-oxobutyl)benzamide Preparation 42		100-102	90%	x	x
4-(3-oxocyclohexyl)benzamide Preparation 43		188-91	42%	x	x
5-(3-oxobutyl)-2-thiophene sulfonamide Preparation 44		96-98	66%	x	x
(3-(3-oxobutyl)phenyl)sulfonamide Preparation 45		87-90	35%	x	x
2-methyl-5-(3-(3-oxobutyl)phenoxy)phenyl)tetrazole Preparation 46		98	65%	x	x
4-(3-oxocyclopentyl)benzamide Preparation 47		203-4	43%	x	x
4-(1,1-dimethyl-3-oxobutyl)benzamide Preparation 48		106-8	61%	x	x

4-(3-oxocycloheptyl) benzonitrile Preparation 49		oil	54%	x	x
4-(3-oxohexyl) benzonitrile Preparation 50		oil	77%	x	x
4-(3-oxobutyl)-phthalhydrazide Preparation 51		161-4	13%	x	x
4-(3-oxohexyl) benzamide Preparation 52		158-61	82%	x	x
4-(2,2-dimethyl-3-oxobutyl)benzonitrile Preparation 53		oil	72%	x	x
4-(2,2-dimethyl-3-oxobutyl)benzamide Preparation 54		127-131	62%	x	x
5-(2-methyl-3-oxobutyl)-2-thiophene sulfonamide Preparation 55		oil	low	x	x
4-((2-oxocycloheptyl)methyl)benzamide Preparation 56		132-4	88%	x	x
4-((2-oxocyclopentyl)methyl)benzonitrile Preparation 57		oil	62%	x	x

4-((2-oxocyclopentyl)methyl)benzamide Preparation 58		138-142	81%	x	x
4-(4-(3-oxobutyl)phenoxy)benzonitrile Preparation 59		94-7	84%	x	x
4-(4-(3-oxobutyl)phenoxy)methylbenzamide Preparation 60		215-17	95%	x	x
2-fluoro-4-(2-methyl-3-oxobutyl)benzonitrile Preparation 61		oil	42%	x	x
2-fluoro-4-(2-methyl-3-oxobutyl)benzamide Preparation 62		112-15	93%	x	x
5-(2-fluoro-4-(2-methyl-3-oxobutyl)phenyl)-1H-tetrazole Preparation 63		175-8	32%	x	x
5-(3-oxobutyl)-2-(morpholinosulfonyl)thiophene Preparation 64		80-83	69%	x	x
5-(2-methyl-3-oxobutyl)-2-(morpholinosulfonyl)thiophene Preparation 65		oil	15%	x	x
4-(2-(4-(3-oxobutyl)phenoxy)ethyl)benzonitrile Preparation 66		oil	41%	x	

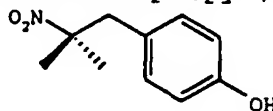
4-(4-(3-oxobutyl)phenyl)benzonitrile Preparation 67		133-5	62%	x	x
2-methyl-4-(3-oxobutyl)benzonitrile Preparation 68		oil	55%	x	x
4-(4-(3-oxobutyl)phenyl)benzamide Preparation 69		229-31	94%	x	x
(3-methyl-4-(3-oxobutyl)phenyl)methanenitrile Preparation 70		34-6	75%	x	x
2-methyl-4-(3-oxobutyl)benzamide Preparation 71		147-50	39%	x	x
3-methyl-4-(3-oxobutyl)benzamide Preparation 72		103-5	46%	x	x
4-(2-(4-(3-oxobutyl)phenoxy)ethyl)benzamide Preparation 73		semi-solid	17%	x	x
4-(4-oxopentyl)benzonitrile Preparation 74		oil	quant	x	x
4-(4-oxopentyl)benzamide Preparation 75		111-13	87%	x	x
3-methyl-4-(2-methyl-3-oxobutyl)benzonitrile Preparation 76		oil	64%	x	x

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(3-methyl-4-(2-methyl-3-oxobutyl)benzamide Preparation 77		105-7	71%	x	x
4-(2,5-dimethyl-4-(3-oxobutyl)phenoxy) benzonitrile Preparation 78		57-9	low	x	x
4-(2-ethyl-3-oxobutyl)benzoic acid Preparation 79		126-9	24%	x	x
4-(2,5-dimethyl-(3-oxobutyl)phenoxy) benzamide Preparation 80		191-3	76%	x	x
(4-(2,6-dimethyl-(3-oxobutyl)phenoxy) phenyl)methanenitrile Preparation 81		yellow w oil	72%	x	x
4-(2,6-dimethyl-(3-oxobutyl)phenoxy) benzamide Preparation 82		238-41	63%	x	x

Preparation 83

4-(2-Methyl-2-nitropropyl)phenol



5

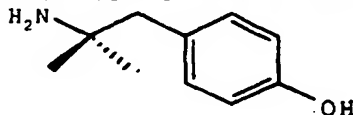
A mixture of 4-hydroxybenzyl alcohol (100.08 g, 806 mmol), 2-nitropropane (400 mL, 4.45 mol), and diglyme (800 mL) was heated to 38°C. Potassium *t*-butoxide (45.29 g, 403.6 mmol) was added, and the mixture was heated to reflux at 132°C with a Dean-Stark trap. Water began collecting in the trap, and continued at a high rate for approximately 1.5 h. When water collection slowed (around 2.5 h) then aliquats of solvent (30-40 mL each) were removed every

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thirty minutes. During the water collection and solvent removal the temperature rose from 132 °C to 149 °C. After 4 h less than 1% of the 4-hydroxybenzyl alcohol remained by HPLC analysis. The heating mantle was removed, and the
5 reaction mixture was allowed to cool. When the temperature was 100°C water (200 mL) was added, and the solution was allowed to cool to room temperature. The solvent was removed on a rotary evaporator under vacuum until 593 g of solution remained. Water (500 mL) and EtOAc (500 mL) were
10 added and the layers were separated, and the aqueous layer was extracted with EtOAc (200 mL). The combined organic layers were extracted with 1N HCl (500 mL) and water (300 mL). The organic layer was distilled *in vacuo* to 261 g of oil to which EtOAc was added (160 mL). Heptane (3.4 L) was
15 added rapidly with vigorous stirring for 30 min, and the product crystallized to yield a beige solid (112.36 g, 71% yield, >98% purity by HPLC analysis). Another crop of crystals may be obtained from the filtrate by concentrating and filtering the solids, or by concentrating more fully to
20 a solution and adding heptane to crystallize. NMR, MS, and EA.

Preparation 84

4-(2-Amino-2-methylpropyl)phenol acetic acid salt



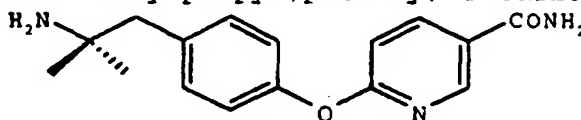
25

A one-gallon high-pressure reactor was charged with 4-(2-methyl-2-nitropropyl)phenol (120 g, 614 mmol), HOAc (35.2 mL, 614 mmol), 5% Palladium on carbon (24 g) wetted with 2B3 EtOH (60 mL), and MeOH (1230 mL). The mixture was heated to
30 50°C with agitation (600 rpm), and the reactor was purged with N₂ and pressurized to 50 psi with H₂. After 15.5 h the reactor was purged with N₂, and the cooled mixture was filtered. The filter cake was washed with MeOH and the filtrate was concentrated to 514 g of slurry on a rotary
35 evaporator. To this slurry was added EtOAc (2 L) with vigorous agitation. After stirring for 1 h, the resulting

-49-

crystals were filtered and washed with a small amount of EtOAc. The product was dried overnight in a 45°C vacuum oven to yield 118.83 g (86%) of product as small white needles (mp 211-216 °C dec). This material was 99% pure by HPLC analysis, and while another 9.00 g of material was obtained from the mother liquor it was found to be only 88% pure. NMR. EA.

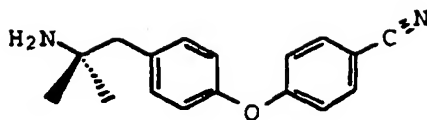
10 Preparation 85
2-(4-(2-Amino-2-methylpropyl)phenoxy)-5-carbamoylpyridine



A mixture of 4-(2-amino-2-methylpropyl)phenol acetic acid salt (45.06 g, 200 mmol), powdered K₂CO₃ (69.1 g, 500 mmol), 6-chloronicotinamide (31.32 g, 200 mmol), DMAC (622 mL) and iso-octane (70 mL) was slowly heated to reflux at 140°C. A water trap filled with iso-octane was used to collect water formed in the reaction, and reflux was maintained for 5.5 h. The mixture was allowed to cool to room temperature, and the solids were filtered and washed with EtOAc. The filtrate was concentrated in vacuo to 88.6 g of solid which was dissolved in EtOAc (500 mL). To this solution was added water (800 mL), 1N HCl (200 mL) and MeOH (50 mL). The pH of this mixture was adjusted to 7.2 with con. HCl, and the aqueous layer was separated and washed with methyl *t*-butyl ether (500 mL). The product was crystallized by addition of 10N NaOH (20 mL) which raised the pH to 11. This pH was maintained by addition of 10N NaOH as needed during the course of the crystallization (90 min). The product was filtered, washed with water and dried in vacuo at 45 °C to 53.11 g (93%) of white solid which was >98% pure by HPLC analysis: ¹H NMR (300 MHz, DMSO-d₆) NMR was consistent with the desired product.

Preparation 86
4-(4-(2-Amino-2-methylpropyl)phenoxy)benzonitrile

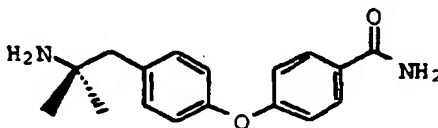
-50-



A mixture of 4-(2-amino-2-methylpropyl)phenol acetic acid salt (45.06 g, 200 mmol), powdered K₂CO₃ (69.1 g, 500 mmol), and DMAC (550 mL) was heated to 75-100°C. Toluene (166 mL) was added, and the mixture was slowly heated to reflux at 134°C. The reflux temperature was raised by distillation of toluene and water into a water trap until the temperature reached 141°C. The mixture was then allowed to cool to below 100°C at which point 4-fluorobenzonitrile (24.46 g, 202 mmol) was added along with 50 mL of toluene. The mixture was again heated to reflux at 140°C with water being collected in a toluene-filled water trap for 4 h. The mixture was allowed to cool to room temperature, and the solids were filtered and rinsed with toluene. The filtrate was concentrated on a rotary evaporator to 77 g of syrup which was dissolved in EtOAc (400 mL). This solution was extracted with water (400 mL), and the aqueous layer was back-extracted with EtOAc (100 mL). The combined organic layers were washed with water (3x400 mL) and concentrated in vacuo to 53.4 g (100%) of oil which was >98% pure by HPLC analysis. NMR.

Preparation 87

4-(4-(2-Amino-2-methylpropyl)phenoxy)benzamide



25

Aqueous 30% H₂O₂ (62.1 mL, 548 mmol) was added dropwise to a mixture of 4-(4-(2-amino-2-methylpropyl)phenoxy)benzonitrile (53.2 g, 200 mmol), K₂CO₃ (15.78 g, 114 mmol) and DMSO (270 mL) over 20 min while the temperature was held at 20°C with a cooling bath. The mixture was stirred at this temperature for 1 h after the

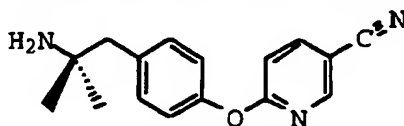
-51-

addition was complete, and then water (209 mL) was added slowly. The slurry was cooled in an ice bath with stirring for 1 h, and the product was then filtered, washed with water and dried in vacuo at 50°C to yield 55.0 g (97%) of white solid. Analysis by HPLC indicated purity of >99%.

NMR.

Preparation 88

2-(4-(2-Amino-2-methylpropyl)phenoxy)-5-cyanopyridine



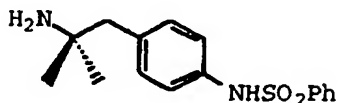
10

A mixture of 4-(2-amino-2-methylpropyl)phenol acetic acid salt (22.53g, 100 mmol), powdered K₂CO₃ (34.55 g, 250 mmol) and DMAC (275 ml) was heated to 100°C. Toluene (94 ml) was added and the mixture slowly heated to reflux. The reflux temperature was raised by distillation of toluene and water until it reached 140°C. The mixture was then cooled to below 100°C and 2-chloronicotinonitrile (13.86g, 100 mmol) added with a toluene rinse (50 ml). The mixture was again heated to reflux and the reflux temperature raised to 140°C as before. Then the water trap was filled with toluene and the reflux continued for 40 min., at which point HPLC showed no 2-chloronicotinonitrile remained but the reaction was not complete. After cooling the reaction below reflux, additional 2-chloronicotinonitrile (0.63 g, 4.5 mmol) was added and reflux continued for 90 min. The reaction was cooled to room temperature and the solids filtered with a toluene wash. The filtrate was concentrated on a rotary evaporator to 41 g of syrup which was dissolved in EtOAc (200 ml). This solution was washed with water (200 ml) and the aqueous layer back-extracted with EtOAc (50 ml). The combined organic layers were washed with water (3x200 ml) and concentrated in vacuo to 26.93 g of solid, ~100% of theory. HPLC indicated 94.3% purity. ¹H NMR (300 MHz, DMSO-d₆) was consistent with the desired product.

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Preparation 89

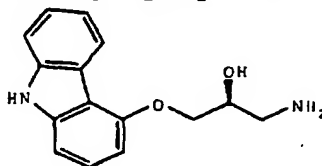
N-(4-[2-Methyl-2-aminopropyl]phenyl)benzenesulfonamide



- 5 A solution of 4-(2-amino-2-methylpropyl)aniline hydrochloride salt (1.0 g, 4.98 mmol) in anhydrous DMF (30 mL) was treated with benzenesulfonyl chloride (880 mg, 4.98 mmol). The solution was stirred at ambient temperature for 16 h. The solvent was removed under
10 reduced pressure and the residue was washed twice with hexane. The insoluble material was dissolved in water and extracted twice with ethyl ether to remove any remaining neutral impurities. The aqueous layer was separated and basified with excess 1N sodium hydroxide.
15 Upon standing, a crystalline solid soon precipitated. The solid was collected, and dried under vacuum at 60°C to provide 570 mg (38%) of the desired product as a white crystalline solid. Mp 180-181°C.

Preparation 90

- 20 4-(2-Hydroxy-3-aminopropoxy)-9H-carbazole

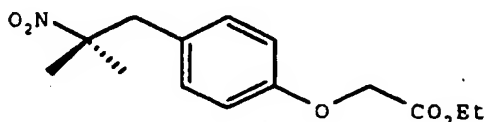


- A solution of (S)-4-(oxiranylmethoxy)-9H-carbazole (215.5 mg, 0.9 mmol) in methanol (25 ml) was treated with dibenzylamine (520 ml, 2.7 mmol) and stirred at reflux for 4
25 h. The solution was cooled to ambient temperature, treated with 10% palladium on carbon (400 mg) and ammonium formate, (2.0 g, 31.7 mmol) and heated to reflux for 4 hours. The suspension was cooled and filtered through a pad of celite, and the filtrate concentrated in vacuo. The residue was
30 purified by flash chromatography over silica eluting with CHCl₃:MeOH (95:5) and then CHCl₃:MeOH:NH₄OH (25:5:1) to give a white solid (140 mg, 61%). NMR

-53-

Preparation 91

Ethyl-(4-[2-methyl-2-nitropropyl]phenoxy)acetate



5

A mixture of 4-(2-methyl-2-nitropropyl)phenol (3.0 g, 15.4 mmol), ethylbromoacetate (2.04 mL, 17.0 mmol) and potassium carbonate (6.4 g, 46.2 mmol) was stirred at room temperature for 18 h. The reaction was concentrated in vacuo and the resulting residue partitioned between EtOAc and water. The layers were separated and the aqueous layer extracted with EtOAc (3x). The combined organic layers were washed with water (3x), brine, dried (Na₂SO₄), and concentrated in vacuo to a brown oil. The material was purified by flash chromatography over silica gel eluting with 5% MeOH/CHCl₃ to provide 4.22 g (97%) of a clear oil.

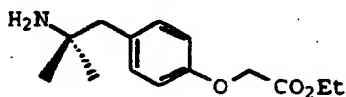
10

15

NMR

Preparation 92

20 Ethyl-(4-[2-amino-2-methylpropyl]phenoxy)acetate



A solution of ethyl(4-[2-methyl-2-nitropropyl]phenoxy)ethanoate (3.6 g, 12.8 mmol) in ethanol (35 mL) was charged with platinum oxide (0.72 g) and hydrogenated on a Parr shaker using 60 psi of hydrogen for 72 h at room temperature. The catalyst was filtered and the solution concentrated in vacuo. The resulting residue was purified by flash chromatography over silica gel eluting with 5% MeOH/CHCl₃/NH₃ to provide 0.9 g (28%) of a clear oil. MS (FD+): m/z 251.

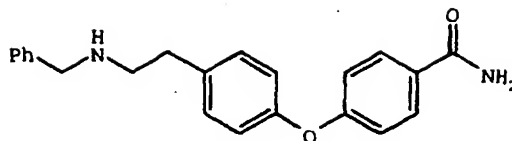
25

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Preparation 93

4-(4-(N-benzyl-2-aminoethyl)phenoxy)benzamide

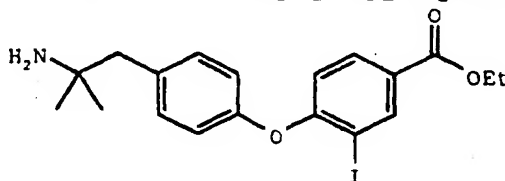
-54-



N-benzyl-4-hydroxyphenethylamine (J. Het. Chem., p. 839, 1971; 7.26 g, 0.032 mol) and 6-chloronicotinamide (5.0 g, 0.032 mol) were dissolved in 180 ml of dimethylacetamide and heated to reflux while water was collected in a Dean-Stark trap prefilled with isooctane. The reaction was refluxed under nitrogen for 17 hrs and additional 6-chloronicotinamide (1 g) added. After 2 hours, the solvent was removed in vacuo and the residue dissolved in 125 ml of ethyl acetate. The solution was shaken with dilute HCl and the solids collected by filtration (8.2 g). NMR.

Preparation 94

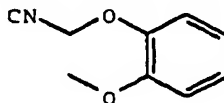
Ethyl-3-iodo-4-(4-(2-amino-2-methylpropyl)phenoxy) benzoate



Ethyl-3-iodo-4-fluorobenzoate (2.28g, 7.75mmol) and the acetic acid salt of 4-(2-amino-2-methylpropyl)phenol (1.75g, 7.75mmol) were dissolved in N,N-dimethylacetamide (40 ml) and toluene (20 ml) and treated with potassium carbonate (3.2g, 23.3mmol, 3 eq.). The mixture was heated with vigorous stirring at 125°C for 16 hours. The crude reaction mixture was diluted with ethyl acetate (100 ml), washed with water (2x) then brine (1x), dried with Na₂SO₄, filtered, and concentrated in vacuo to afford the biphenyl ether as a golden oil (3.15 g, 93%). NMR. MS.

Preparation 95

2-Cyanomethoxyanisole



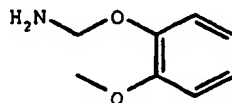
-55-

Potassium carbonate (24 g) was added to a solution of of 2-methoxy phenol (18.94 g, 0.152 mol) in acetone (500 ml) at room temperature. A solution of bromoacetonitrile (17.43 g, 0.145 mol) in acetone (500 ml) was then added and the
5 resulting suspension was heated at reflux for 10 h. The reaction vessel was then cooled and the solution was concentrated under reduced pressure and taken up into water (150 ml). Chloroform (250 ml) was added and the two layers separated. The organic phase was washed with brine (100 ml)
10 and 10% aqueous NaOH (100 ml). The organic phase was dried (MgSO₄) and concentrated under reduced pressure to give the product (19.91 g, 80%) as an oil. ¹H NMR (CDCl₃, 250 MHz) 7.0 (4H m), 4.8 (2H, s), 3.9 (3H, s).

Preparation 96

15

2-Aminomethoxyanisole

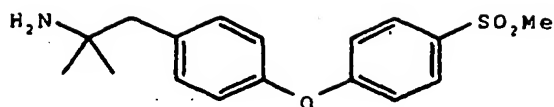


A solution of the 2-cyanomethoxyanisole (5.6 g, 0.034 mol) in anhydrous ammonia (25 ml) and ethanol (50ml) was heated to 120°C at 500 psi for 12 h in the presence of raney
20 nickel (1.4 g). The reaction mixture was filtered, concentrated under reduced pressure, the residue taken up in ether, and washed with 1.2 M HCl. The acidic phase was then rendered basic (pH = 12) with careful addition of solid KOH and the alkaline solution extracted with ether. The organic
25 phase was dried (MgSO₄) and concentrated under reduced pressure to give the product (1.99 g, 35%) as an oil. IR. NMR. MS.

Preparation 97

4-(4-(2-amino-2-methylpropyl)phenoxy)phenyl methylsulfone

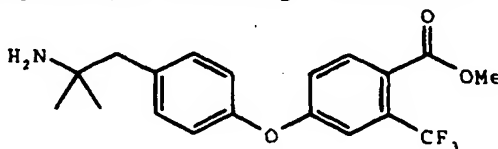
-56-



Titled compound was prepared substantially in accordance with Example 94 by starting with 4-fluorophenylmethylsulfone (3.1 g, 17.75 mmol) to yield
 5 product (4.67 g) after purification as a tan solid. NMR.

Preparation 98

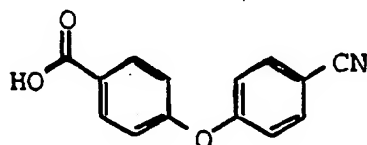
Methyl-2-trifluoromethyl-4-(4-(2-amino-2-methylpropyl)phenoxy) benzoate



10 The phenol from preparation 16 (2.9 g, 13 mmol), 4-fluorophenyl-2-trifluoromethyl-methylsulfone (2.9 g, 13 mmol), and potassium carbonate (4.2 g, 30 mmol) were heated to 100°C in 50 ml of dimethylacetamide. After 17 hours, the reaction mixture was cooled, filtered, and concentrated in
 15 vacuo. The residue was purified by column chromatography to yield 1.9 g of pale yellow oil. NMR.

Preparation 99

4-(4-Cyanophenoxy)benzoic acid

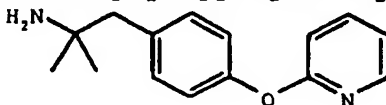


20 A mixture of 4-hydroxybenzoic acid (3.50 g, 25 mmol), 4-fluorobenzonitrile (3.00 g, 35 mmol), and powdered K₂CO₃ (6.80 g, 49 mmol) were heated in DMAC (50 mL) at 140°C for 20 hours. The cooled mixture was then acidified with 1N HCl and extracted with EtOAc (3 X 50 mL). Concentration of the
 25 extracts in vacuo left a residue which was chromatographed over silica gel (5% MeOH/CHCl₃) to provide 2.30 g (39%) of pure product. MS (FD+) 238.9

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Preparation 100

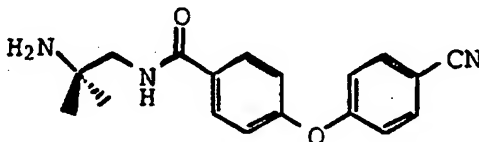
2-(4-(2-Amino-2-methylpropyl)phenoxy)pyridine



5 Titled compound was prepared substantially in accordance with Example 94 by starting with 2-fluoropyridine (1.72 g, 17.75 mmol) to yield product (1.28 g) after purification as a brown oil. EA. NMR.

Preparation 101

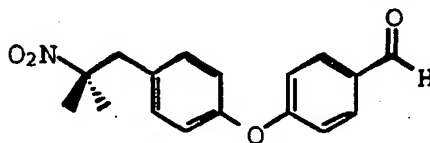
10 N-[2-Amino-2-methylpropyl]-4-(4-cyanophenoxy)benzamide



 4-(4'-Cyanophenoxy)benzoic acid (1.00 g, 4.2 mmol) was dissolved in THF (40 mL) followed by the addition of 1,1-
15 carbonyldiimidazole (0.745 g, 4.6 mmol) in small portions. This mixture was stirred for 1 hour whereupon 1,2-diamino-2-methylpropane (0.48 mL, 4.6 mmol) was added and the resultant mixture stirred for 20 hours at RT. The mixture was then concentrated in vacuo, and the residue
20 chromatographed over silica (10% MeOH/CHCl₃) to provide 0.50 g (38%) of the desired product. MS. (FD+) 310.2 m.p. 133 - 137°C.

Preparation 102

4-(4-(2-Methyl-2-nitropropyl)phenoxy)benzaldehyde



25

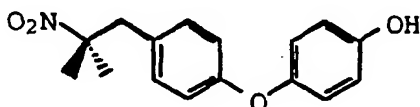
 A mixture of 4-(2-methyl-2-nitropropyl)phenol (5.00 g, 25.6 mmol), 4-fluorobenzaldehyde (3.17 g, 25.6 mmol), and

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powdered K_2CO_3 (4.00 g, 29 mmol) were heated in DMAC (50 mL) at $140^\circ C$ for 20 hours. The cooled mixture was then diluted with water and the organics extracted with EtOAc (3 X 50 mL). Concentration of the extracts *in vacuo* left a residue which was chromatographed over silica gel (5% MeOH/ $CHCl_3$) to provide 6.15 g (80%) of pure product. MS(FD+) 299. EA.

Preparation 103

4-(4-(2-Methyl-2-nitropropyl)phenoxy)phenol



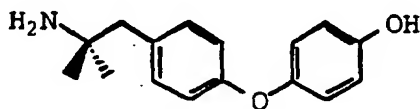
10

4-(4-(2-Methyl-2-nitropropyl)phenoxy)benzaldehyde (6.00 g, 20 mmol) was dissolved in chloroform (500 mL). *m*-Chloroperoxy-benzoic acid (10.0 g, 58 mmol) was added in small portions at RT. After stirring for 1 hour, the mixture was concentrated *in vacuo* and MeOH (300 mL) added followed by the dropwise addition of conc. HCl (5 mL). This mixture was stirred for 3 hours at RT and then concentrated *in vacuo*. Chromatography over silica gel (MeOH/ $CHCl_3$) allowed for the isolation of 3.20 g (55%) of the desired product. MS(FD+): 287.2

20

Preparation 104

4-(4-(2-Methyl-2-aminopropyl)phenoxy)phenol



25

A mixture of $NiCl_2 \cdot 6H_2O$ (1.40 g, 5.9 mmol) in MeOH (100 mL) was stirred at RT under a nitrogen atmosphere. Sodium borohydride (0.675 g, 17.9 mmol) was carefully added to the mixture in small portions. Twenty minutes after complete addition of the initial sodium borohydride 4-(4-(2-methyl-2-nitropropyl)phenoxy)phenol (3.20 g, 11 mmol) was added followed by the careful portionwise addition of more $NaBH_4$ (1.58 g, 42 mmol) which caused a frothing exothermic reaction. All starting nitro compound had been consumed

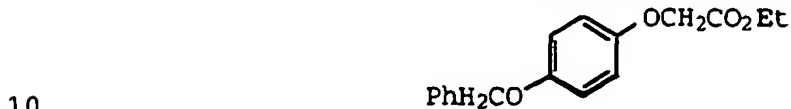
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within 15 minutes of the last hydride addition as judged by TLC analysis. The mixture was then filtered through Celite and the filtrate concentrated *in vacuo*. The resulting residue was chromatographed over silica gel (MeOH/CHCl₃) which allowed for isolation of both the incompletely reduced hydroxylamine product (0.675 g, 22%) and the desired amine product (0.94 g, 34%). MS (FD+): 258 (amine)

Preparation 105

Ethyl-4-benzyloxyphenoxyacetate



Ethylbromoacetate (4.17 g, 25 mmol) was added to a mixture of 4-benzyloxyphenol (5.00 g, 25 mmol) and K₂CO₃ (3.50 g, 25 mmol) in DMF (75 mL) and stirred for 20 hours at ambient temperature. The mixture was then concentrated *in vacuo* and the residue partitioned between water and EtOAc. The aqueous phase was further extracted with 2 X 50 mL of EtOAc and the combined extracts were washed with 2 X 50 mL of water and dried over Na₂SO₄. Concentration of the organic solution *in vacuo* left 7.00 g (97%) of product as a white solid. m.p. 65-68°C.

Preparation 106

Ethyl-4-hydroxyphenoxyacetate

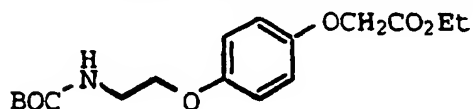


Ethyl-4-benzyloxyphenoxyacetate compound (3.50 g, 12.2 mmol) was placed in a PARR bottle along with EtOAc (75 mL), EtOH (75 mL), and 5% Pd/C (1.20 g) and the mixture placed under 40 psi of H₂. The reaction was shaken under pressure for 4 hours after which no starting material remained by TLC. The catalyst was removed by filtration through Celite and the filtrate concentrated *in vacuo* to give 2.35 g (97%) of the desired phenol. MP

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Preparation 107

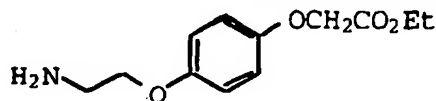
Ethyl-4-(2-t-butylcarboxyethyl)phenoxyacetate



5 Ethyl-4-hydroxyphenoxyacetate (1.35 g, 6.9 mmol) was combined with N-(t-butoxycarboxy)ethanolamine (1.00 g, 6.2 mmol), triphenylphosphine (1.79 g, 6.8 mmol) and DEAD (1.30 mL, 8.3 mmol) in THF (50 mL) and stirred for 35 hours at RT. The solvent was removed *in vacuo* and the resulting residue chromatographed over silica gel (30-40% EtOAc/Hexanes) which
10 resulted in recovery of a phenol/product mix. Subsequent chromatography over silica gel (1% MeOH/CHCl₃) allowed for the isolation of the desired product as an oil 0.870 g (41%). MS (FD+): 339. EA.

Preparation 108

15 Ethyl-4-(2-aminoethyl)phenoxyacetate



Ethyl-4-(2-t-butylcarboxyethyl)phenoxyacetate (0.80 g, 2.35 mmol) was stirred for two hours at RT with TFA (2 mL) in dichloromethane (20 mL). The mixture was then quenched
20 into aqueous NaHCO₃ and the organics extracted with 3 X 20 mL of dichloromethane. The combined extracts were concentrated *in vacuo* and the resulting residue chromatographed over silica gel (CHCl₃) which allowed for isolation of 0.50 g (89%) of the desired amine as a thick
25 oil. MS (FD+): 239.

Preparation 109

N-Butyloxycarbonyl-4-(3-methyl-3-aminobutyl) methyl benzoate

To a suspension of 4-(3-methyl-3-aminobutyl) methyl
30 benzoate hydrochloride (3.01 g), sodium carbonate (3.71 g, 3.0 eq.), 30 mL of dioxane, and 30 mL of water at 0°C was added di-t-butylidicarbonate (2.55 g, 1 eq.) in 5 mL of dioxane. The resulting solution was allowed to stir for 1.5

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hours. The reaction was diluted with and partitioned between ethyl acetate and water. The aqueous layer was removed and the organic layer was washed with brine, dried over sodium sulfate, filtered, and concentrated in vacuo.

- 5 The residue was purified via silica gel column chromatography eluting with 25% ethyl acetate/ toluene to give 2.81 g of the title compound. Yield: 75%.

Preparation 110

N-Butyloxycarbonyl-4-(3-methyl-3-aminobutyl) benzoic acid

- 10 To a solution of N-butyloxycarbonyl-4-(3-methyl-3-aminobutyl) methyl benzoate (1.9 g) in 20 mL of ethanol was added 12 mL of 5N sodium hydroxide (10 eq.). The resulting solution was allowed to stir for 3 hours. The solvent was concentrated in vacuo and the residue was taken up in water.
- 15 The resulting alkaline solution was neutralized with 5N hydrochloric acid (3 mL). This mixture was extracted twice with ethyl acetate and the extracts were washed with brine, dried over sodium sulfate, filtered, and concentrated in vacuo to give 1.59 g of the title compound. Yield: 87%.
- 20 ¹H NMR.

Preparation 111

N-(Benzamid-4-yl)-N'-butyloxycarbonyl-4-(3-methyl-3-aminobutyl)benzamide

- To a solution of N-butyloxycarbonyl-4-(3-methyl-3-aminobutyl) benzoic acid (1.9 g) in 5 mL of pyridine under a
- 25 nitrogen atmosphere was added thionyl chloride (0.036 mL, 1.1 eq.). The resulting solution was allowed to stir until TLC indicated conversion of the starting acid to the acid chloride. 4-Aminobenzamide (44 mg, 1 eq.) was then added
- 30 and the resulting solution was allowed to stir for 4 hours. The solvent was removed in vacuo and the crude product was recrystallized from ethanol to give 62 mg of the title compound.
- Yield: 45%. ¹H NMR.

- 35 Preparation 112

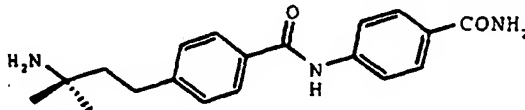
N-Butyloxycarbonyl-4-(3-methyl-3-aminobutyl) benzoic acid
piperidyl amide

-62-

To a flame dried flask under a nitrogen atmosphere was added N-butyloxycarbonyl-4-(3-methyl-3-aminobutyl) benzoic acid (500 mg), piperidine (0.161 mL, 1.0 eq.), 1-hydroxybenzotriazole (47 mg, 1.0 eq.), diisopropylethylamine (0.2 mL, 3.5 eq.), and 25 mL of methylene chloride. A solution of (dimethylaminopropyl)ethyl carbodiimide in 20 mL of methylene chloride was then added and the resulting solution was allowed to stir for 1 hour before diluting with ethyl acetate. This mixture was acidified with 10% aqueous citric acid. The organics were washed twice each with saturated aqueous sodium bicarbonate and brine, dried over sodium sulfate, filtered, and concentrated in vacuo. The residue was taken up in ethyl acetate and was washed twice with 10% aqueous sodium bicarbonate, once with brine, dried over sodium sulfate, filtered, and concentrated in vacuo to give the title compound.

Preparation 113

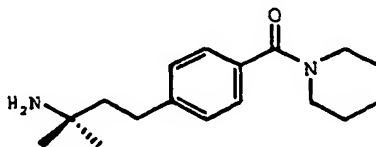
N-(Benzamid-4-yl)-4-(3-methyl-3-aminobutyl)benzamide



To a flame dried flask under a nitrogen atmosphere was added N-(benzamid-4-yl)-N'-butyloxycarbonyl-4-(3-methyl-3-aminobutyl)benzamide (370 mg), 10 mL of methylene chloride, and trifluoroacetic acid (0.67 mL, 10.0 eq). The resulting solution was allowed to stir for about 18 hours. The pH was adjusted to 7 with 1N hydrochloric acid and the mixture was extracted with ethyl acetate. The organics were washed with brine, dried over sodium sulfate, filtered, and concentrated in vacuo to give 260 mg of the title compound. Yield: 92%. MS(FD): 326 (M+1). ¹H NMR.

Preparation 114

4-(3-Methyl-3-aminobutyl)benzoic acid piperidyl amide

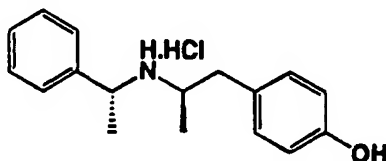


-63-

N-Butyloxycarbonyl-4-(3-methyl-3-aminobutyl) benzoic acid piperidyl amide (540 mg) was converted to the titled product substantially in accordance with procedure 113 except that after final concentration the residue is redissolved in 1N hydrochloric acid. This acidic solution was made basic with 5N sodium hydroxide and extracted twice with ethyl acetate. The organic extracts were washed with brine, dried over sodium sulfate, filtered, and concentrated in vacuo to give 284 mg of the title compound. Yield: 72%. MS(FD): 275 (M+1). ¹H NMR.

Preparation 115

(2R)-1-(4-hydroxyphenyl)-2-(N-[(R)-α-methylbenzyl])amino propane hydrochloride:



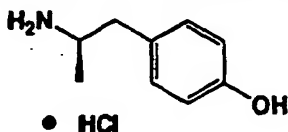
A mixture 4-(2-oxopropyl)phenol (101.03 g, 673 mmol), (R)-(+)-α-methylbenzylamine (91.1 mL, 706 mmol), wet (60 % (w/w) H₂O) 2% Pt, 8% Pd/C (8.42 g, 5 wt % dry load), and EtOH (560 mL) was placed in an autoclave which was pressurized to 50 psi with hydrogen at 23°C. After stirring for 4 h, the mixture was filtered, and the filtrate was concentrated on a rotary evaporator to 179 g of thick oil. This oil was dissolved in CH₂Cl₂ (1300 mL), and 2N HCl (363 mL) was added which caused precipitation of the hydrochloride salt. This mixture was stirred for 2 h, filtered, washed with CH₂Cl₂ and 2N HCl, and was dried in a 45°C vacuum oven to yield 135.96 g (69 %) of a white solid. The optical purity of the material was determined by GC analysis and was shown to be 93.7 % de. A small portion of this material (10.02 g) was suspended in CH₂Cl₂ (65 mL), and concentrated NH₄OH (6.7 mL) and water (10 mL) were added which caused the solid to dissolve. The pH was then lowered to 0.2 with con. HCl, and the slurry was filtered, washed with water and CH₂Cl₂, and dried as above to give 9.47 g (94 %

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recovery) of product as a white solid (mp 224 °C [dec]).
NMR. MS (FD+) m/z 256 (39 %), 148 (100 %).

Preparation 116

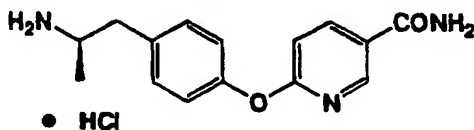
5 (2R)-1-(4-Hydroxyphenyl)-2-aminopropane hydrochloride



A hastalloy autoclave was charged with (2R)-1-(4-hydroxyphenyl)-2-(N-[(R)- α -methylbenzyl])amino propane hydrochloride (72.3 g, 248 mmol), 5 % Pd/C (16.0 g, wetted
10 with 100 mL of EtOH), and MeOH (400 mL). The autoclave was pressurized to 50 psi H₂ and heated to 50°C for 6 h with vigorous stirring. After cooling, purging with nitrogen and filtering the mixture, the filtrate was concentrated on a rotary evaporator under vacuum. The resulting oily foam was
15 dissolved in a minimal amount of MeOH and was triturated by addition of EtOAc. The solid was filtered, and another crop of solid which precipitated from the filtrate was also collected. The combined solids were dried in a 45°C vacuum oven overnight to yield 34.2 g (73 %) of a white solid. MP
20 160°C [dec]. MS(FD+) m/z 151 (92 %).

Preparation 117

(2R)-2-(4-(2-Aminopropyl)phenoxy)-5-carbamoylpyridine hydrochloride



25

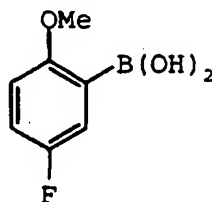
A 3-L flask was charged with (2R)-1-(4-hydroxyphenyl)-2-aminopropane hydrochloride (50.0 g, 266 mmol), powdered K₂CO₃ (91.91 g, 665 mmol), 6-chloronicotinamide (41.65 g, 266
30 mmol) and dry (<0.1 % H₂O) DMAC (1 L). The mixture was heated to 140-142°C, and a steady stream of nitrogen was passed through the flask and out of the distillation

-65-

apparatus. After 4.5 h, 415 mL of distillate had been collected, and the mixture was cooled to 15°C. The potassium salts were filtered and the filter cake was washed with DMAC (200 mL). The filtrate was concentrated under vacuum with an 80°C water bath. Xylenes (250 mL) were added to the residue and the solution was concentrated as above to yield 107 g of solid. This product was crystallized from refluxing methyl-t-butyl ether (500 mL) which was allowed to cool slowly to 23°C over 3 h. The solid material was filtered, washed with MTBE (200 mL) and dried in a 45°C vacuum oven to provide 69.91 g of solid. This product was taken up in refluxing toluene (1738 mL) which caused an oil to form in solution. The stirring was stopped to allow the oil to settle to the flask sides, and the flask was then removed from the heating mantle. The hot toluene solution was decanted from the oil into another flask, and the solution was allowed to cool to ambient temperature with stirring over the course of 4 h. The resulting precipitate was filtered, rinsed with toluene (200 mL) and was dried in a 45°C vacuum oven to yield 55.40 g (77%) of material as a white solid (mp 140-141°C). ¹H NMR. MS(FAB) m/z 272.1393.

Preparation 118

4-Fluoroanisole-2-Boric Acid



To a solution of 2-bromo-4-fluoroanisole (20.0 g, 97.6 mmol) in 100 mL of tetrahydrofuran at -55°C to -65°C was added n-butyl lithium (2.5 M in hexanes, 39 mL) via syringe. After 15 minutes, triisopropylborate (25 mL, 110 mmol) was added and the resulting solution was allowed to warm to -25°C at which point 1N hydrochloric acid was added. The quenched reaction was stirred for 15 minutes, diluted with 200 mL of ethyl acetate, and the 2 layers were separated.

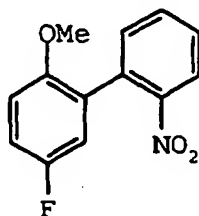
-66-

The organic layer was dried over magnesium sulfate, filtered, and concentrated in vacuo to give a pale yellow semi-solid which was triturated with hexane to give 6.8 g of the title compound.

5 Yield: 41%. ¹H NMR. MS(FD).

Preparation 119

2-(2-Nitrophenyl)-4-fluoroanisole



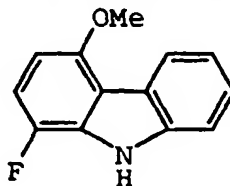
A mixture of 4-fluoroanisole-2-boronic acid (3.3 g, 19.4 mmol), 2-nitrobromobenzene (3.56 g, 17.6 mmol), triphenylphosphine (367 mg, 1.4 mmol), triethylamine (4.6 g, 45.8 mmol), and 40 mL of dimethylformamide was sparged with nitrogen for 5 minutes before adding palladium acetate (160 mg, 0.7 mmol) and heating the mixture to 100°C for 5 hours.

15 The reaction was cooled and concentrated in vacuo. The residue was partitioned between ethyl acetate and water. The organic layer was shaken with 0.1N sodium hydroxide, dried over magnesium sulfate, filtered, and concentrated in vacuo. The crude product was purified via flash silica gel

20 chromatography eluting with 2% ethyl acetate/hexanes followed by 4% ethyl acetate/hexanes to give 7.5 g of the title compound. Yield: 86%. EA. MS(FD).

Preparation 120

1-Fluoro-4-methoxycarbazole



25

A mixture of 2-(2-nitrophenyl)-4-fluoroanisole (427 mg, 1.73 mmol) and triethyl phosphite (3 mL) was heated to reflux for 3.5 hours. The reaction was cooled and

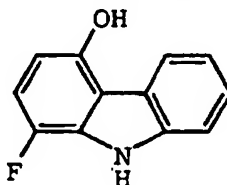
-67-

concentrated in vacuo. The crude product was purified via flash silica gel chromatography eluting with 2% ethyl acetate/hexanes followed by 5% ethyl acetate hexanes to give 212 mg of the title compound.

5 Yield: 57%. MS(FD).

Preparation 121

1-Fluoro-4-Hydroxycarbazole

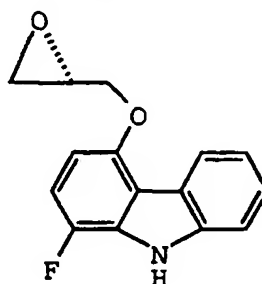


A mixture of 1-fluoro-4-methoxycarbazole (438 mg, 2.04 mmol) and pyridine hydrochloride (3 g) was placed into an oil bath that was preheated to 220°C. After 20 minutes, the reaction was poured onto a mixture of ice and concentrated ammonium hydroxide. The product was extracted into ethyl acetate and the extract was dried over magnesium sulfate, filtered, and concentrated in vacuo. The residue was azeotroped with toluene to give 470 mg of the title compound.

15 Yield: >100%. MS(FD).

Preparation 122

20 O-Glycidyl-1-Fluoro-4-Hydroxycarbazole



A mixture of 1-fluoro-4-hydroxycarbazole (470 mg, 2 mmol), potassium carbonate (345 mg, 2.5 mmol), (2R)-(-)-glycidyl 3-nitrobenzenesulfonate, (518 mg, 2 mmol), and 20 mL of acetone was heated to reflux for about 18 hours. The reaction was cooled and concentrated in vacuo. The residue was partitioned between ethyl acetate and water. The

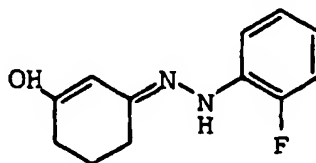
-68-

organic layer was dried over magnesium sulfate, filtered, and concentrated in vacuo. The crude product was purified via flash silica gel chromatography eluting with 10% ethyl acetate/hexanes to give 247 mg of the title compound.

5 Yield: 48%. ¹H NMR. MS(FD).

Preparation 123

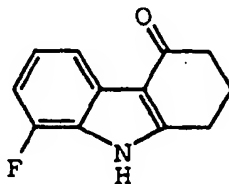
N-(2-Fluorophenyl)cyclohexenol-3-hydrazide



A solution of 2-fluorophenylhydrazine hydrochloride
10 (24.8 g, 152.5.6 mmol) in 225 mL of water and 2.25 mL of isopropanol was added dropwise to a solution of 1,3-cyclohexanedione (17.1 g, 152.5 mmol) in 117 mL of water and 1.1 mL of isopropanol. Sodium bicarbonate (12.6 g, 152.5 mmol) was then added. After 3 hours, the orange powder that
15 formed was collected, washed with 200 mL of water, and dried at 45°C in a vacuum oven to give 31.5 g of the title compound. Yield: 94%. ¹H NMR. MS(FD).

Preparation 124

1-Fluoro-5-oxo-5,6,7,8-tetrahydrocarbazole



20

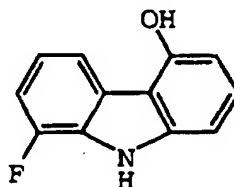
To phosphoric acid (85%, 150 mL) at 90°C was added a solution of N-(2-fluorophenyl)cyclohexenol-3-hydrazide (30.5 g, 138.5 mmol) in 150 mL of phosphoric acid (85%) dropwise. The resulting solution was heated at 90°C for 1 hour then
25 cooled to room temperature. Ethanol (250 mL) was added and the quenched reaction mixture was poured into 600 mL of water. This mixture was stirred for 1 hour before the pH was adjusted to 5 with 50% aqueous sodium hydroxide. The alkaline mixture was extracted with ethyl acetate (1 L) and

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the extract was washed with brine, shaken with celite, filtered, and concentrated in vacuo. The residue was purified via flash silica gel chromatography eluting with 40% ethyl acetate/hexanes followed by 50% ethyl acetate/hexanes to give 2.8 g of the title compound. Yield: 10%. EA. MS(FD).

Preparation 125

1-Fluoro-5-hydroxycarbazole

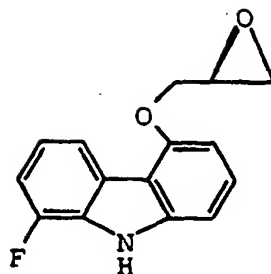


10 A mixture of 1-fluoro-5-oxo-5,6,7,8-tetrahydrocarbazole (111 mg, 0.55 mmol), copper II bromide (244 mg, 1.09 mmol), and 5 mL of ethyl acetate was heated to reflux for about 12 hours. The reaction was cooled to room temperature, treated with celite, and then filtered. The reaction was
15 partitioned between aqueous sodium bicarbonate and ethyl acetate. The organic layer was dried over magnesium sulfate, filtered, and concentrated in vacuo. The residue was dissolved in 5 mL of dimethylformamide and lithium carbonate (52 mg, 0.7 mmol) and lithium bromide (61 mg, 0.7
20 mmol) were added. The resulting mixture was heated to reflux for 1.5 hours. The reaction was concentrated in vacuo and the crude product was purified via flash silica gel chromatography eluting with 15% ethyl acetate/hexanes to give 32 mg of the title compound. Yield: 18%. ¹H NMR.
25 MS(FD).

Preparation 126

O-Glycidyl-1-fluoro-5-hydroxycarbazole

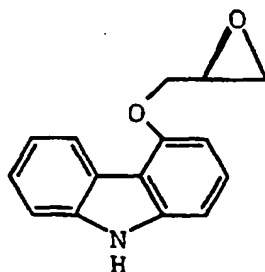
-70-



1-Fluoro-5-hydroxycarbazole (25 mg, 0.124 mmol) and (2R)-(-)-glycidyl 3-nitrobenzenesulfonate, (32 mg, 0.124 mmol) were converted to 25 mg of the title compound substantially in accordance with the procedure of Preparation 122. Yield: 65%. ¹H NMR. MS(FD).

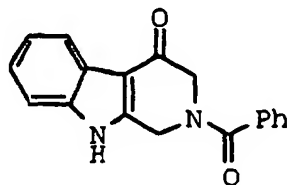
Preparation 127

O-Glycidyl-5-hydroxycarbazole



The titled compound can be prepared by procedures known in the art or by utilizing procedures substantially in accordance with preparations 123-126 provided phenyl hydrazine is utilized as a starting material in preparation 123 instead of fluorophenyl hydrazine.

See the following references to obtain 2-benzoyl-1,2,3,9-tetrahydro-4H-pyrido[3,4-b]indol-4-one



Cain, M.; Mantei R.; Cook, J. M.; *J. Org. Chem.*, **1982**, *47*, 4933-4936.

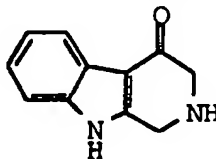
-71-

Hagen, T. J.; Narayanan, K.; Names J.; Cook, J. M.; *J. Org. Chem.*, **1989**, *54*, 2170-2178.

- 5 For 4-(oxiranylmethoxy)-9H-pyrido[3,4-b]indole as precursor to β -adrenergic blockers see the following:
Corbiere, J.; *Fr. Demande* FR 2,516,512; 19 Nov 1981
(CA99:175742q)

Preparation 128

1,2,3,9-tetrahydro-4H-pyrido[3,4-b]indol-4-one

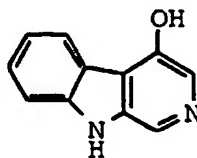


10

- To a warm solution of 2-benzoyl-1,2,3,9-tetrahydro-4H-pyrido [3,4-b]indol-4-one (11.10 g, 38.2 mmol) in dioxane (240 mL) was added 5N NaOH (360 mL) and the mixture refluxed for 2 hr. The reaction was allowed to cool and separate
15 into two layers. The aqueous layer was extracted with EtOAc (3 x 200 mL). All the organic portions were combined and washed with brine (300 mL), dried (MgSO₄), filtered and evaporated in vacuo to provide the crude product. The material was recrystallized from MeOH to give 5.53 g (78%)
20 of a reddish brown solid. m.p. 220-233°C decomposed. NMR. FD. EA.

Preparation 129

9H-pyrido[3,4-b]indol-4-ol



- 25 To a mixture of 1,2,3,9-tetrahydro-4H-pyrido[3,4-b]indol-4-one (1.86 g, 10 mmol), dodecene (2.78 mL, 12.5 mmol) and 10% Pd on carbon (750 mg) in 2-methoxyethyl ether (50 mL) was heated at 150°C for 3 hr. The reaction was filtered while hot through a celite pad and then a majority
30 of the 2-methoxyethyl ether was evaporated in vacuo. The resulting residue was absorbed on silica and chromatographed

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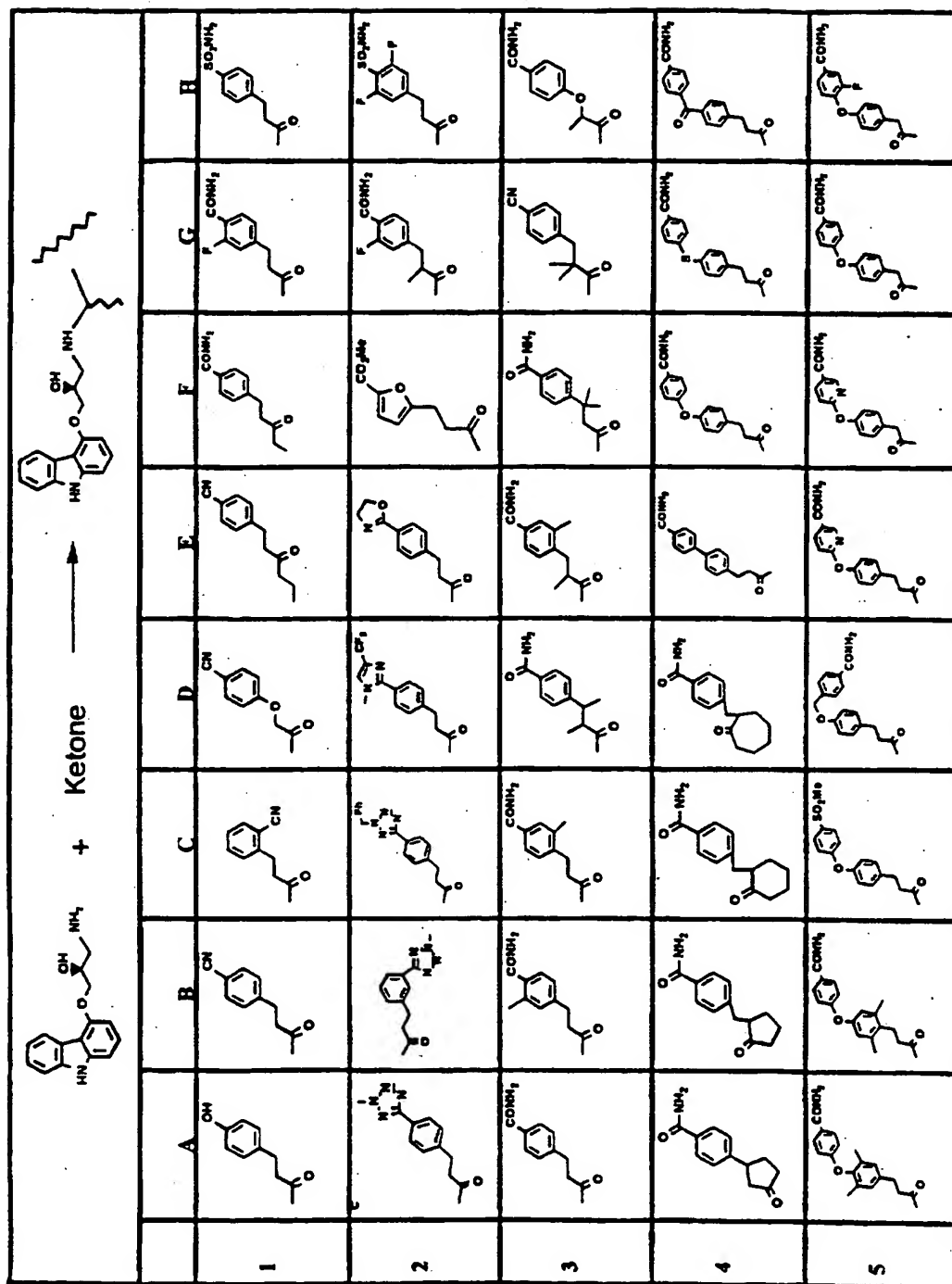
on a flash column by eluting with EtOAc and then 9 EtOAc/1 MeOH to give 1.65 g (90%) of a yellow foam. NMR. FD.

Example 1 is a combinatorial/parallel method for preparing compounds of the present invention in matrix fashion.

Example 1

A 5x8 grid of 4 mL screw cap vials is arranged. To each of the eight rows of vials in the grid is added 40 μ L of a 0.5 M solution of carbazole amine (20 μ mol) in 1:1 methanol/DMF, 0.40 μ moles of ketone (weighed into each vial), 100 μ L of DMF, 80 μ L of methanol, 30 μ L of acetic acid, and 80 μ L of a 0.25M solution of sodium cyanoborohydride (20 mmol) in methanol. The vial was sealed with a teflon backed cap and shaken at room temperature for 20 hours. The reaction mixture is applied to a 500 μ g SCX column. The column was flushed with 2.5 mL methanol to remove byproducts (column was always left moist) and the product was then eluted using 2.5 mL of a 2M solution of ammonia in methanol. The solvent was evaporated, followed by drying in a vacuum oven to yield the product secondary amine product.

The following matrix lists additional examples 2-41. These compounds were prepared using combinatorial/parallel techniques in accordance with the present invention. All reaction conditions are the same from example to example and in substantial accordance with Scheme 2 and Example 1. The scaffold for each plate is the same and is depicted at the top corner of the 5x8 matrix. The variable functional groups are illustrated in the rows and columns. The ketones and the amine depicted for each example are prepared in accordance with the schemes and preparations described herein or by techniques known in the art. Compounds prepared according to Example 1 are those wherein R₅ is methyl, R₆ is hydrogen, and R₄ is as depicted in the matrix.



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	Example 2	Ketone A1	405.4 (M+1)
	Example 3	Ketone B1	414.0 (M+1)
	Example 4	Ketone C1	413.8 (M)
	Example 5	Ketone D1	416.0 (M+1)
5	Example 6	Ketone E1	442.0 (M+1)
	Example 7	Ketone F1	446.0 (M+1)
	Example 8	Ketone G1	450.0 (M+1)
	Example 9	Ketone H1	468.0 (M+1)
	Example 10	Ketone A2	471.0 (M+1)
10	Example 11	Ketone B2	471.0 (M+1)
	Example 12	Ketone C2	547.0 (M+1)
	Example 13	Ketone D2	537.0 (M+1)
	Example 14	Ketone E2	458.0 (M+1)
	Example 15	Ketone F2	436.8 (M)
15	Example 16	Ketone G2	464.2 (M+1)
	Example 17	Ketone H2	504.0 (M+1)
	Example 18	Ketone A3	432.2 (M+1)
	Example 19	Ketone B3	446.0 (M+1)
	Example 20	Ketone C3	446.0 (M+1)
20	Example 21	Ketone D3	460.2 (M+1)
	Example 22	Ketone E3	460.2 (M+1)
	Example 23	Ketone F3	460.2 (M+1)
	Example 24	Ketone G3	442.0 (M+1)
	Example 25	Ketone H3	448.0 (M+1)
25	Example 26	Ketone A4	444.0 (M+1)
	Example 27	Ketone B4	458.4 (M+1)
	Example 28	Ketone C4	472.0 (M+1)
	Example 29	Ketone D4	486.4 (M+1)
	Example 30	Ketone E4	508.2 (M+1)
30	Example 31	Ketone F4	524.2 (M+1)
	Example 32	Ketone G4	540.4 (M+1)
	Example 33	Ketone H4	536.2 (M+1)
	Example 34	Ketone A5	552.2 (M+1)
	Example 35	Ketone B5	552.2 (M+1)
35	Example 36	Ketone C5	559.2 (M+1)
	Example 37	Ketone D5	538.4 (M+1)
	Example 38	Ketone E5	525.2 (M+1)
	Example 39	Ketone F5	511.4 (M+1)
	Example 40	Ketone G5	510.2 (M+1)
40	Example 41	Ketone H5	528.0 (M+1)

The skilled artisan would appreciate that Examples 42-82 could be prepared by utilizing methodology of Example 1 and the remaining ketones of preparations 1-82.

45		<u>Ketone</u>
	Example 42	(4-2,6-dimethyl-(3-oxobutyl)phenoxy)-phenylmethanenitrile
	Example 43	4-(2,5-dimethyl-(3-oxobutyl)phenoxy)-benzamide
50	Example 44	4-(2-ethyl-3-oxobutyl)benzoic acid
	Example 45	4-(2,5-dimethyl-4-(3-oxobutyl)phenoxy)-benzonitrile

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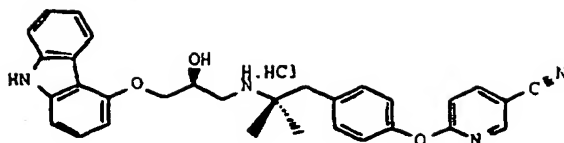
	Example 46	3-methyl-4-(2-methyl-3-oxobutyl)-benzonitrile
	Example 47	4-(4-oxopentyl)benzonitrile
	Example 48	4-(2-(4-(3-oxobutyl)phenoxy)ethyl)-benzamide
5	Example 49	(3-methyl-4-(3-oxobutyl)phenyl)-methanenitrile
	Example 50	2-methyl-4-(3-oxobutyl)benzonitrile
	Example 51	4-(4-(3-oxobutyl)phenyl)benzonitrile
10	Example 52	4-(2-(4-(3-oxobutyl)phenoxy)ethyl)-benzonitrile
	Example 53	5-(2-methyl-3-oxobutyl)-2-(morpholinosulfonyl)thiophene
	Example 54	5-(3-oxobutyl)-2-(morpholinosulfonyl)thiophene
15	Example 55	5-(2-fluoro-4-(2-methyl-3-oxobutyl)-phenyl)-1H-tetrazole
	Example 56	2-fluoro-4-(2-methyl-3-oxobutyl)-benzonitrile
20	Example 57	4-(4-(3-oxobutyl)phenoxy)benzonitrile
	Example 58	4-((2-oxocyclopentyl)benzonitrile
	Example 59	5-(2-methyl-3-oxobutyl)-2-thiophene sulfonamide
	Example 60	4-(2,2-dimethyl-3-oxobutyl)benzamide
25	Example 61	4-(3-oxobutyl)-phthalhydrazide
	Example 62	4-(3-oxohexyl)benzonitrile
	Example 63	4-(3-oxocycloheptyl)benzonitrile
	Example 64	(3-3-oxobutyl)phenyl)sulfonamide
	Example 65	5-(3-oxobutyl)-2-thiophene sulfonamide
30	Example 66	4-(3-oxocyclohexyl)benzamide
	Example 67	4-(2-methyl-3-oxobutyl)benzamide
	Example 68	4-(2-methyl-3-oxobutyl)benzonitrile
	Example 69	N-methoxyl-4-(3-oxobutyl)benzamide
	Example 70	1-methyl-5-(2-3-oxobutenyl)phenyl-1H-tetrazole
35	Example 71	4-(3-oxocyclohexyl)benzonitrile
	Example 72	3-methyl-5-(2-(3-oxobutyl)phenyl)-1N-tetrazole
	Example 73	(2-fluoro-4-(3-oxobutyl)benzonitrile
40	Example 74	(4-(3-oxobutyl)phenyl)thioamide
	Example 75	4-(3-oxobutyl)-1-cyanomethylbenzene
	Example 76	tetralone-6-morpholinamide
	Example 77	tetralone-6-carboxamide
	Example 78	4-[(2-Oxocyclohexyl)]benzonitrile
45	Example 79	2,6-dimethoxy-4-[4-(2-oxobutyl)phenoxy]-1,3,5-triazine
	Example 80	3-[4-(2-oxobutyl)phenoxy)methyl]pyridine
	Example 81	5-[4-(2-oxobutyl)phenoxy)methyl]tetrazole
	Example 82	4-[4-(3-oxobutyl)phenoxy]benzonitrile

50

Example 83

(S)-4-[2-Hydroxy-3-((4-(5-cyano-2-pyridyloxy)phenyl)-2-methylpropylamino)propoxy]carbazole
hydrochloride salt

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A mixture of 2-(4-[2-amino-2-methylpropyl]phenoxy)-5-pyridinecarbonitrile (20.58 g, 76.98 mmol), (S)-(+)-4-(oxiranylmethoxy)-9H-carbazole (9.18 g, 38.37 mmol), and HOAc (113.6 mg, 1.89 mmol) in MeOH (268 mL) was stirred at 60°C for 22 hours. The mixture was cooled and concentrated in vacuo to an oil. The residue was dissolved in EtOAc (300 mL), 1N HCl (19 mL), and water (120 mL). The resulting layers were separated. The organic layer was extracted with a solution of 1N HCl/water (10 mL/120 mL), and with a solution of 1N HCl/water (4 mL/120 mL). The organic layer was extracted a final time with a solution of 1N NaOH/10 % NaCl/water (10 mL/30 mL/30 mL), dried (Na₂SO₄) and concentrated in vacuo to yield 21.2 g of a foam. Purification of 20.3 g of the foam by flash chromatography over 500 g of 230-400 mesh silica gel using 50:1:0.01 EtOAc/MeOH/28% NH₃ as an eluent yielded 15.28 g (82.24%) of the free base. ¹H NMR (DMSO-d₆) was consistent with the desired product.

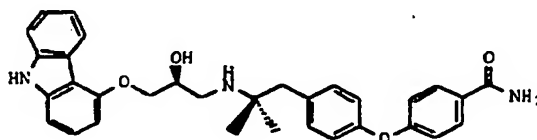
A solution of the free base (2.02 g, 4.00 mmol) in EtOAc (40 mL) was made acidic by the addition of a 0.1633 g HCl/g EtOAc solution (897 mg, approx. 2.04 mmol) at room temperature. The resulting slurry was stirred 30 minutes and then vacuum filtered. The filter cake was washed with EtOAc and dried in vacuo at 50°C to yield 1.58g (72.81%) of the desired product as a solid. ¹H NMR was consistent with the desired product and showed small amounts of EtOAc and water): ¹H NMR (500 MHz, DMSO-d₆): δ 1.30 (s, 6H), 3.15-3.07 (m, 2H), 3.29-3.24 (m, 1H), 3.49-3.47 (m, 1H), 4.28-4.25 (m, 1H), 4.36-4.33 (m, 1H), 4.53 (m, 1H), 6.07 (br s, 1H), 6.75-6.73 (d, 1H), 7.16-7.11 (m, 4H), 7.23-7.21 (d, 1H), 7.36-

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7.31 (m, 4H), 7.48-7.47 (d, 1H), 8.32-8.29 (m, 2H), 8.66-8.65 (d, 1H), 8.9 (br s, 1H), 9.5 (br s, 1H), 11.36 (s, 1H).

Example 84

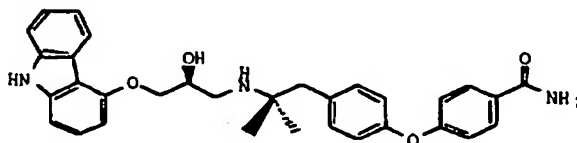
5 (S)-4-[2-Hydroxy-3-([4-(4-carbamoylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



The nitrile from example 83 (2.02 g, 4mmol) and 0.57
 10 equivalents of powdered potassium carbonate (0.316 g, 2.28 mmol) were stirred in 5.4 ml of DMSO and a cooling bath applied to hold 20°C as 2.74 equivalents of 30% hydrogen peroxide (1.24 ml, 11 mmol) were added dropwise over 20 min. Stirring was continued at 20 to 26°C for 1 hour 40 min.
 15 Then the reaction mixture was added slowly to 54 ml of water stirring rapidly at ambient temperature, with a rinse of 0.6 ml of DMSO and 6 ml of water. This slurry was stirred 1 hour and filtered with a wash on the filter cake of 60 ml of water. The product was vac dried at room temperature to
 20 1.97 g of white solid, 94% of theory. HPLC indicated 90.2% purity. NMR in DMSO-d6 was consistent with the desired product and showed small amounts DMSO and water.

Example 85

25 (S)-4-[2-Hydroxy-3-([4-(4-carbamoylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



— A stirred mixture of (S)-(+)-4-(oxiranylmethoxy)-carbazole (7.50 g, 31.3 mmol), 4-(4-(2-amino-2-methylpropyl)-phenoxy)benzamide (17.82 g, 62.67 mmol),
 30 acetic acid (0.10 g, 1.7 mmol), water (10 mL) and methanol (260 mL) was heated to 60°C for 22.7 hrs. The mixture was cooled and concentrated in vacuo to an oil. The concentrate was taken up in ethyl acetate (250 mL) and partitioned with

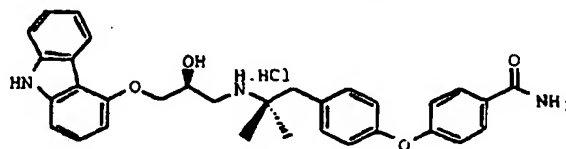
-78-

water (100 mL). The organic layer was then extracted with a solution of 25 mL 1N HCl (25 mL) in water (35 mL). A white precipitate formed during the extraction was mostly 4-(4-(2-amino-2-methylpropyl)-phenoxy)benzamide and was removed by
 5 filtration of the two phase mixture. The organic layer was extracted two times with a solution of 1N HCl (3 mL) in water (50 mL). The ethyl acetate layer was stripped to an oily residue. The crude product was purified by flash chromatography with 416 g 230-400 silica gel and eluting
 10 with ethyl acetate then 10:1-3 ethyl acetate:ethanol gradient. Concentration of the appropriate fractions and drying under vacuum gave 14.31 g (87.2%) of the desired product as a foamy white solid. ¹H NMR was consistent with the desired compound.

15

Example 86

(S)-4-[2-Hydroxy-3-([4-(4-carbamoylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole hydrochloride



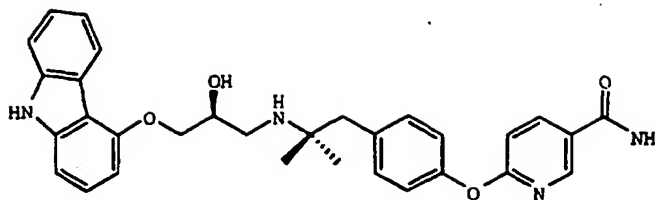
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A stirred solution of the product from example 85 (11.01 g, 21.03 mmol) in 180 mL ethyl acetate (180 mL) was treated with a 1N HCl/ethyl acetate (21 mL) solution at ambient temperature. The resulting slurry was stirred for
 25 approximately 1 hour at room temperature. The slurry was pressure filtered under nitrogen through a stainless steel filter. The filter cake was washed three times with ethyl acetate (30 mL) and dried under a nitrogen purge for 2 hours. The filter cake was then dried in a vacuum oven at
 30 60°C overnight. This afforded 10.46 g (88.8%) of product as a white solid. EA: Calculate for C₃₂H₃₄ClN₃O₄: C 68.63, H 6.12, N 7.50. Found: C 68.58, H 5.89, N 7.17.

Example 87

35 (S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole

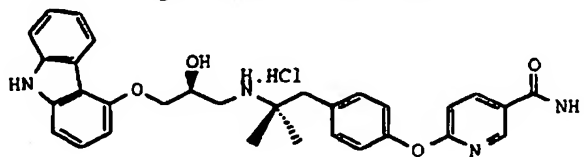
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A mixture of 4-(2-amino-2-methylpropyl)phenoxy)-5-carboxamidepyridine (17.12 g, 60.00 mmol), (S)-4-(oxiranylmethoxy)-9H-carbazole (7.18 g, 30.00 mmol), HOAc (84.1 mg, 1.40 mmol), and water (10 mL) in MeOH (210 mL) was stirred at 60 °C for 22.5 hours. The mixture was cooled and concentrated in vacuo to an oil. The residue was dissolved in EtOAc (150 mL) and water (60 mL) and the resulting layers were separated. The organic layer was extracted with a solution of 1N HCl/water (28 mL/32 mL), and then with a solution of 1N HCl/water (2 x 2 mL/58 mL). The combined aqueous layers were extracted with EtOAc (2 x 60 mL) and MTBE (60 mL). The combined organic layers were washed with water (60 mL) and then were concentrated in vacuo to yield 16.01 g of a foam. Purification of the foam by flash chromatography over 230-400 mesh silica gel using first 25:4 chloroform/methanol and later 25:4:0.1 chloroform/methanol/~28% ammonia as eluents yielded 10.00 g (63.53%) of the free base. ¹H NMR (DMSO-d₆) was consistent with the desired product.

Example 87(A)

(S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole hydrochloride salt



25

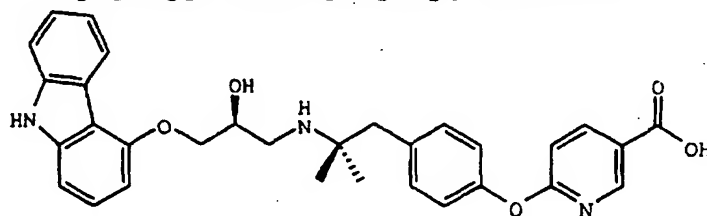
A mixture of the free base prepared above (9.80 g, 18.68 mmol) in EtOAc (150 mL) and isopropanol (19 mL) was heated to 60°C to obtain a solution. The stirred solution was made acidic by the dropwise addition of 56.5 mL (approx. 19.2 mmol HCl) of an approximately 0.34M HCl in

-80-

EtOAc solution over 30 minutes. The resulting slurry was allowed to slowly cool for 1.75 hours to ambient temperature. The mixture was filtered (nitrogen pressure). The filter cake was washed with EtOAc (2 x 20 mL) and dried in vacuo at 50-60°C to yield 10.04 g (95.8%) of the desired product as a white powder. ¹H NMR was consistent with the desired product and showed small amounts of EtOAc, IPA, and water): MS (FD+) m/z 1049 (46%), 525 (100%).

Example 88

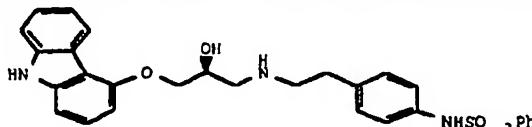
10 (S)-4-[2-Hydroxy-3-([4-(5-carboxy-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole



Product from Example 87 (525 mg, 1 mmol) was heated to 60°C in 10 ml of methanol and 10 ml of 1M NaOH(aq.) for 22 hours. Reaction temperature was increased to reflux for 4 hours and the reaction cooled to room temperature. The reaction mixture was washed with isopropyl acetate and the aqueous phase acidified to a pH of 8.2 with 2M HCl and a gummy precipitate formed which crystallized upon further stirring. Solids were vigorously stirred for 4 hours, filtered, and washed with water. The solids were dissolved in 10 ml of 0.1 M NaOH and filtered. The pH was adjusted to with 2M HCl and the solids filtered to yield 0.4 g of product. MS (m+1) 526. EA: theory: C 70.84, H 5.95, N 8.00. Found: C 70.60, H 5.97, N 7.98.

Example 89

(S)-4-[2-Hydroxy-3-(2-[4-phenylsulfonamidophenyl]propylamino)propoxy]carbazole



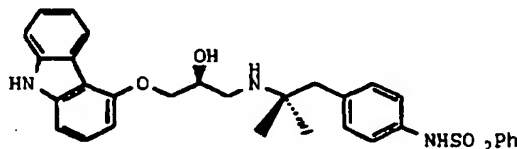
30 A stirred mixture of (S)-4-(oxiranylmethoxy)-9H-carbazole (478.5 mg, 2.0 mmol), N-(4-[2-aminoethyl]phenyl) benzenesulfonamide (829.1 mg, 3.0 mmol), acetic acid (1

-81-

drop), and ethanol (50 mL) was heated at 45 °C for 16 h with a slow stream of nitrogen bubbling through the reaction mixture. The mixture was cooled and concentrated in vacuo to an amorphous solid. The solid was taken up in ethyl acetate (150 mL) and washed once with 1N HCl (20 mL) and twice with aqueous saturated sodium bicarbonate solution and finally with water. The organic layer was then dried over anhydrous magnesium sulfate, filtered, and concentrated to dryness. The resulting white amorphous product was purified by radial chromatography (Chromatatron) using EtOAc:MeOH (9:1). Concentration of the appropriate fractions and drying under vacuum gave 290 mg (29%) of the desired product as an amorphous white solid. Anal. Calcd. for $C_{29}H_{29}N_3O_4S \cdot 0.5 \text{ mol } H_2O$: C, 66.39; H, 5.76; N, 8.01. Found: C, 66.49; H, 5.81; N, 7.77.

Example 90

(S)-4-[2-Hydroxy-3-([4-(phenylsulfonamido)phenyl]-2-methylpropylamino)propoxy]carbazole

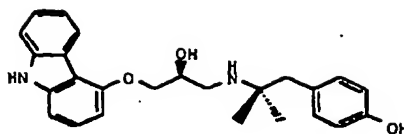


A solution of (S)-4-(oxiranylmethoxy)-9H-carbazole (1.0 g, 4.18 mmol) and N-(4-[2-methyl-2-aminopropyl]phenyl) benzenesulfonamide (1.9 g, 6.24 mmol) in absolute ethanol (100 mL) was refluxed for 18 h. The solvent was removed under vacuum and the residue was purified by column chromatography eluting with chloroform:methanol (95:5). Concentration of the appropriate fractions provided 1.53 g (69%) of the desired product. MS (FD) m/e 544.3 (MH⁺); Anal. Calcd. for $C_{31}H_{33}N_3O_4S$: C, 68.48; H, 6.12. N, 7.73. Found: C, 68.49; H, 6.02; N, 7.53.

Example 91

(S)-4-[2-Hydroxy-3-([4-hydroxyphenyl]-2-methylpropylamino)propoxy]carbazole

-82-

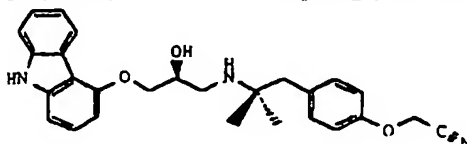


A solution of 4-(2-amino-2-methylpropyl)phenol acetic acid (2.0 g, 8.9 mmol) in water (50 mL) was treated with saturated NaHCO_3 (25 mL) and allowed to stand for 1 h. The resulting crystalline solid was filtered, washed with water and dried under house vacuum to provide 1.11 g (76%) of the free amine. A solution of the free amine (950 mg, 5.75 mmol) and (S)-4-(oxiranylmethoxy)-9H-carbazole (550 mg, 2.3 mmol) were refluxed in ethanol (50 mL) for 20 h. The solution was cooled to room temperature and concentrated under reduced pressure. The residue was flash chromatographed eluting with $\text{CHCl}_3:\text{MeOH}:\text{NH}_4\text{OH}$ (25:5:1) to give 900 mg (97%) of product. Anal. Calcd for $\text{C}_{25}\text{H}_{28}\text{N}_2\text{O}_3$: C, 74.23; H 6.98; N, 6.93. Found: C, 74.51; H, 7.11; N, 6.88.

15

Example 92

(S)-4-[2-Hydroxy-3-([4-cyanomethoxyphenyl]-2-methylpropylamino)propoxy]carbazole



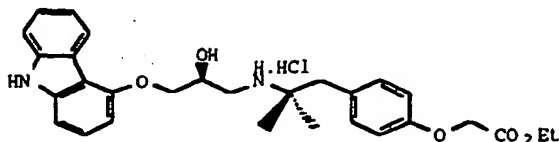
To the phenol prepared in example 91 (608 mg, 1.5 mmol) in THF (20 mL) at 0°C was added sodium hydride (66 mg of a 60% dispersion in oil, 1.66 mmol). After ten minutes bromoacetonitrile (199 mg, 1.66 mmol) was added. The suspension was stirred at room temperature whereupon another portion of bromoacetonitrile (360 mg, 3 mmol) was added and stirring continued until the reaction was complete by TLC. Water (50 mL) was added to the reaction and the two layers separated. The aqueous phase was extracted with ether (2 X 40 mL) and the combined organic phases dried (MgSO_4) and concentrated under reduced pressure. The residue was purified by flash chromatography eluting with 10% $\text{MeOH}/\text{CHCl}_3$ to provide 350 mg (53%) of product. Anal. Calcd for

-83-

$C_{27}H_{30}N_3O_3$: C, 67.56; H 6.30; N, 8.75. Found: C, 67.39; H, 6.51; N, 8.49.

Example 93

5 (S)-4-[2-Hydroxy-3-([4-carboethoxymethoxyphenyl]-2-methylpropylamino)propoxy]carbazole hydrochloride salt

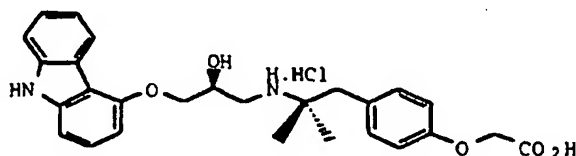


A solution of (S)-4-(oxiranylmethoxy)-9H-carbazole (0.33 g, 1.4 mmol) in ethanol (50 ml) was treated with ethyl
10 (4-[2-amino-2-methylpropyl]phenoxy)ethanoate (0.7 g, 2.8 mmol) and stirred at reflux for 18 h. The reaction was concentrated in vacuo and the resulting residue purified by flash chromatography over silica gel eluting with 0.5% MeOH/CHCl₃, followed by 1% MeOH/CHCl₃, to provide 0.5 g (72%)
15 of a clear oil.

The free base from above (0.45 g, 0.92 mmol) was dissolved in EtOAc (30 mL) and treated with anhydrous HCl in ether (30 mL) and concentrated in vacuo to provide 0.48 g of a white solid. MS (FD⁺): m/z 490. Anal Calcd for
20 $C_{29}H_{35}ClN_2O_5$: C, 66.09; H, 6.69; N, 5.32. Found: C, 65.87; H, 6.66; N, 5.55.

Example 94

25 (S)-4-[2-Hydroxy-3-([4-carboxymethoxyphenyl]-2-methylpropylamino)propoxy]carbazole hydrochloride salt



A solution of the free base (0.25 g, 0.47 mmol) from example 93 in ethanol/THF (50 mL/50 mL) was treated with 1N
30 NaOH (14.1 mL, 14.1 mmol) and refluxed with stirring for 1 h, the reaction was neutralized with 1N HCl (13.6 mL, 13.6 mmol, 29 eq), and concentrated in vacuo. The resulting residue was slurried in ether (30 ml) and anhydrous HCl in ether (30 ml) was added. The resulting slurry was

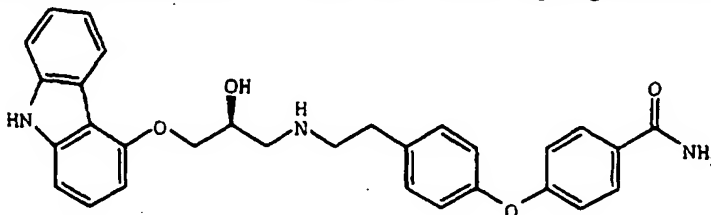
-84-

concentrated *in vacuo*. The residue was dissolved in EtOAc and filtered. The filtrate was concentrated *in vacuo* to provide 0.08g (35%) of a tan solid. MS (FD+): *m/z* 463. Anal Calcd for $C_{27}H_{31}N_2O_5Cl$: C, 64.99; H, 6.26; N, 5.61.

5 Found: C, 65.29; H, 6.55; N, 5.35.

Example 95

(S)-4-[2-Hydroxy-3-(2-[4-carbamoylphenoxy]phenyl)propylamino]propoxy]carbazole



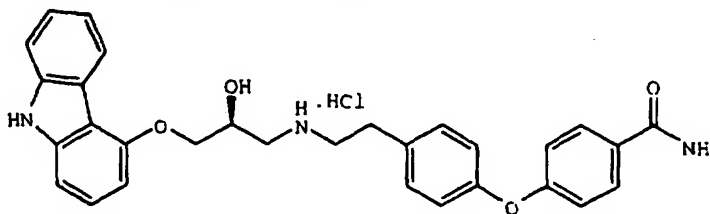
10 The product from Preparation 93 (0.76 g, 2.1 mmol) and (S)-(+)-4-(oxiranylmethoxy)-9H-carbazole (0.5 g, 2.2 mmol) were combined in 25 ml of dry methanol and were heated to reflux for 18 hrs under nitrogen. Ammonium formate (1.1 g, 16.7 mmol) and 10% palladium/carbon (0.2 g) were added and
15 reflux continued for 45 minutes. The reaction mixture was filtered through celite and solvent removed *in vacuo*. The residue was purified by column chromatography (chloroform/methanol, 80:20) to give a white foam. The product was dried at 70°C in a vacuum oven. MS (*m+1*) 497,
20 EA: Theory: C 70.15, H 5.68, N 11.28. Found: C 68.43, H 5.56, N 11.13.

Example 96

(S)-4-[2-h Hydroxy-3-(2-[4-(4-carbamoylphenoxy)])propylamino]propoxy]carbazole

25

hydrochloride salt



The product from Example 95 (0.25 g, 0.5 mmol) was dissolved in 40 ml of isopropanol and 0.50 ml of 1M HCl in diethyl ether was added. The solvent was removed *in vacuo*
30 and the solid dried in a vacuum oven at 100°C. MS (*m+1*)

-85-

497 (free base), EA: Theory: C 65.35, H 5.48, N 10.51.

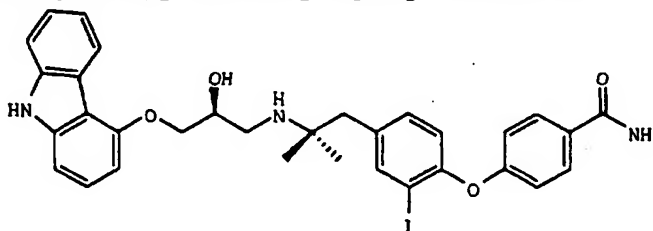
Found: C 65.10, H 5.27, N 10.29.

Examples 97 through 101 were prepared by utilization of the procedure outline below.

- 5 **Procedure A:** 0.2M solutions of both the (S)-(+)-4-(oxiranylmethoxy)-9H-carbazole and epoxides were prepared in DMSO. In a 1 dram screw cap vial was mixed 0.5mL amine (0.1mmol) and 0.05mmol N,O-bis(trimethylsilyl)acetamide (BSA). After gently shaking for one-half hour, 0.6mL
- 10 (0.12mmol) (S)-(+)-4-(oxiranylmethoxy)-9H-carbazole was added. The vial was capped and the reaction heated at 80°C for 4-5 days. After cooling to room temperature, the reaction was quenched with 1mL 5% HOAc/water. The reaction was diluted with 1mL MeOH and then placed directly on a
- 15 500mg SCX ion exchange column. Using vacuum, the column was washed with 7mL MeOH. The collection tube under the column was changed and then the product was removed from the resin by washing with 4mL 2N ammonia in MeOH. The solution of product was concentrated in a tarred flask and analyzed for
- 20 purity by HPLC, ion-spray ms and ¹H NMR. The average yield in the sample 10 x 10 plate was 35% with an average purity of 80% as determined by HPLC.

Example 97

- 25 (S)-4-[2-Hydroxy-3-([3-iodo-4-(4-carbamoylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



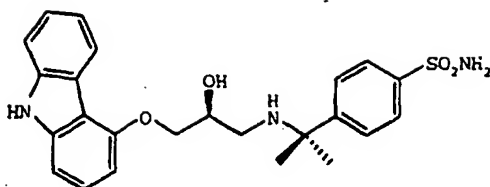
4-(2-iodo-4-(2-amino-2-methylpropyl)phenoxy) benzamide was treated according to Procedure A to yield product in 20%. MS(IEX) m+1 650.

30

Example 98

- (S)-4-[2-Hydroxy-3-(-1-[4-aminosulfonylphenyl]-1-methylethylamino)propoxy]carbazole

-86-

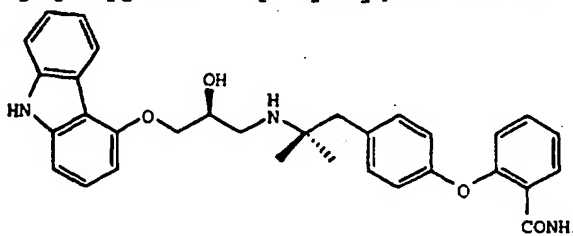


2-Methyl-2-(4-aminosulfonylphenyl)ethylamine was treated as in Procedure A to yield product in 43%. MS(IEX) m+1 454.

5

Example 99

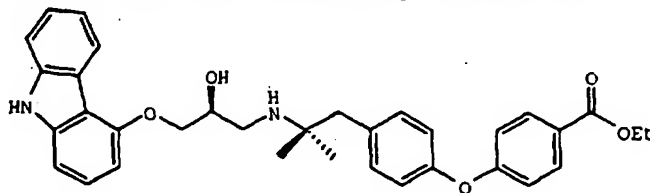
(S)-4-[2-Hydroxy-3-([4-(2-carbamoylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



2-(4-(2-amino-2-methylpropyl)phenoxy)benzamide was treated according to Procedure A to yield product in 20%. MS(IEX) m+1 524.

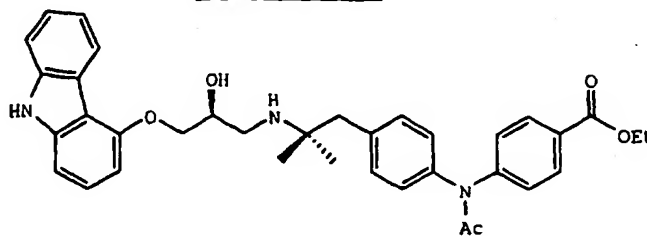
Example 100

(S)-4-[2-Hydroxy-3-([4-(4-carboethoxyphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



15

Ethyl-4-(4-(2-amino-2-methylpropyl)phenoxy)benzoate was treated as in Procedure A to yield product in 81%. MS(IEX) m+1 553.

Example 101

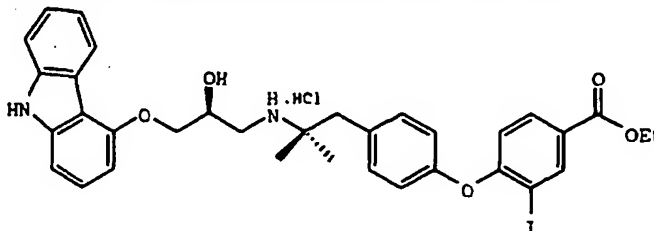
20

-87-

Ethyl-4-(N-acetyl-N'-4-(2-amino-2-methylpropyl)phenylamino)benzoate was treated as in Procedure A to yield product in 81%.

Example 102

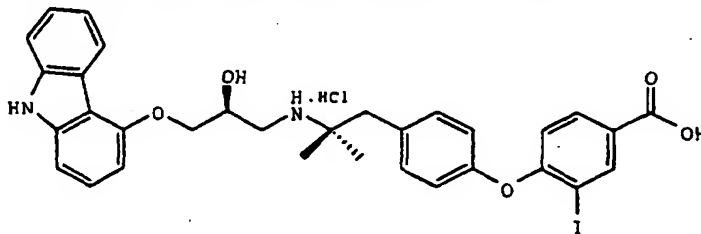
- 5 (S)-4-[2-Hydroxy-3-([4-(4-carboethoxy-2-iodophenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



- The product from preparation 94 (3.1g, 7.06mmol, 3 eq.) and S-(+)-glycidyl-4-hydroxycarbazole (563mg, 2.35mmol) were dissolved in ethanol (40 ml) and heated at 70°C for 20 hours with stirring. The crude reaction mixture was concentrated in vacuo and applied to a flash silica column. Elution with ethyl acetate, then 9:1 ethyl acetate/ethanol afforded a white solid (1.6g, 100%). NMR, MS. The material was dissolved in ether with methanol, filtered and treated with excess HCl (4.0N in dioxane). The resulting flocculent precipitate was filtered, triturated with pentane and dried in vacuo to afford the product as a white solid (1.19g, 71%). NMR, MS, IR, HPLC

Example 103

- 20 (S)-4-[2-Hydroxy-3-([4-(4-carboxy-2-iodophenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



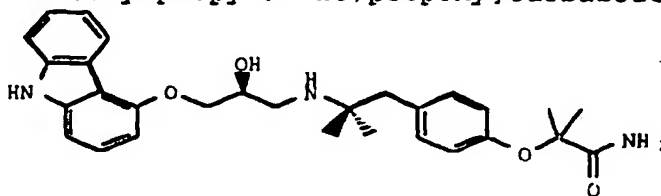
- (S)-4-[2-hydroxy-3-([4-(4-carboethoxy-2-iodophenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole (386mg, 0.54mmol) was dissolved in a mixture of ethanol (20 ml) and aqueous potassium hydroxide (20 ml, 5.0N) and was stirred at ambient temperature for 16 hours. The crude reaction mixture was concentrated in vacuo and the residue

-88-

acidified with 5.0N HCl. The solution was allowed to stir for one hour at 0°C and then concentrated in vacuo to afford a white solid. The residue was suspended in water and filtered, and the solids washed with cold water. The solids
 5 were triturated with pentane and dried to afford product as a white solid (370mg, 100%). NMR, MS, IR, HPLC

Example 104

(S)-4-[2-Hydroxy-3-([4-(1-methyl-1-carbamoyloethoxy)phenyl]-2-methylpropylamino)propoxy]carbazole

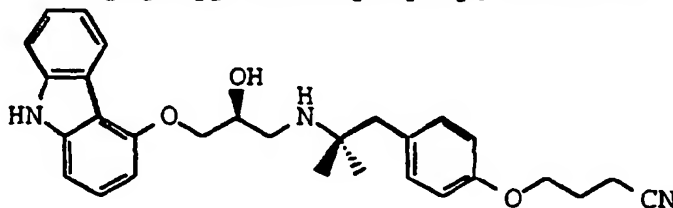


10

Sodium hydride (10.8 mg of a 60% dispersion in oil, 0.27 mmol) was added to a solution of the phenol prepared in example 91 (100 mg, 0.25 mmol) in dry dioxane (1 ml) and the mixture stirred for 1h at room temperature. 2-Bromo-2-
 15 methylpropanamide (Coutts, I.G.C., Southcott, M. R. *J. Chem. Soc. Perkin Trans. 1*, 1990, 767) was then added and the mixture heated at 100°C for 8h. The reaction mixture was filtered, concentrated in vacuo, and purified by flash chromatography (1:1 ethyl acetate: hexanes) to afford a
 20 light yellow solid (94.4 mg, 94%). MS (FD+) 489.6, Mp 84-86°C.

Example 105

(S)-4-[2-Hydroxy-3-([4-(3-cyanopropoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



25

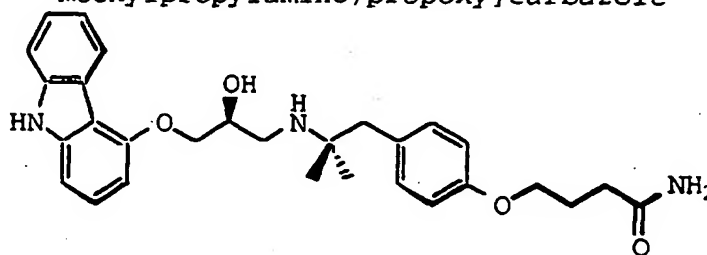
A mixture of the phenol prepared in example 91 (0.90 g, 2.2 mmol), 4-bromobutyronitrile (0.5 mL, 5.0 mmol), potassium carbonate (0.97 g, 7.0 mmol), potassium iodide (0.1 g) and methyl ethyl ketone (30 mL) was heated at reflux
 30 for 10 h. The reaction was concentrated in vacuo and the

-89-

resulting residue partitioned between EtOAc and water. The layers were separated and the aqueous layer extracted with EtOAc (3x). The combined organic layers were washed with water (3x), brine, dried (MgSO₄), and concentrated in vacuo to a light pink oil. The material was purified by flash chromatography over silica gel eluting with 5% MeOH/CHCl₃ to provide 0.79 g (76%) of a clear oil. MS (FD+) 471.65. NMR.

Example 106

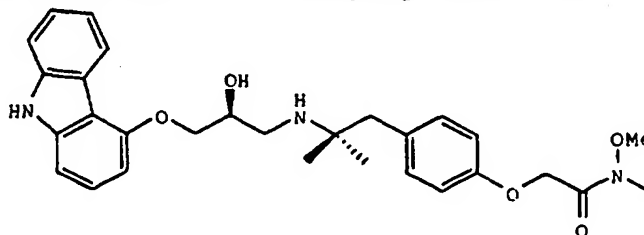
10 (S)-4-[2-Hydroxy-3-([4-(3-carbamoylpropoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



The nitrile from Example 105 (0.32 g, 0.68 mmol) and potassium carbonate (0.23 g, 1.67 mmol) were slurried in DMSO (5 mL) and cooled to 0°C in an ice bath. Aqueous hydrogen peroxide (1.5 mL) was added slowly, and the reaction stirred at room temperature for 48 hours. The reaction was quenched by pouring into water, and extracting the aqueous layer with ethyl acetate. The combined organic layers were dried (MgSO₄), and concentrated in vacuo to a light tan oil. The material was purified by flash chromatography over silica gel eluting with EtOAc/hexanes/10% NH₄OH in MeOH (5:4:1) to provide 0.30 g (89%) of a light tan oil. MS (FD+) 489.62. NMR.

Example 107

25 (S)-4-[2-hydroxy-3-([4-(N-methyl-N-methoxycarbonylmethoxy)phenyl]-2-methylpropylamino)propoxy]carbazole

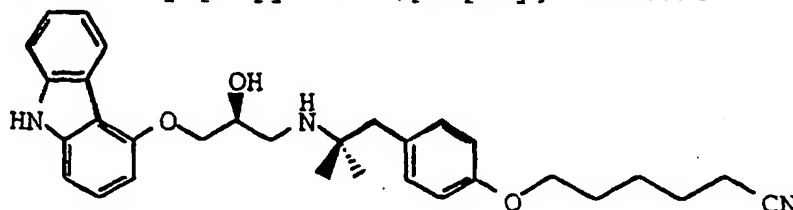


-90-

The title compound was prepared substantially in accordance with Example 105 from a mixture of phenol from Example 91 (500 mg, 1.2 mmol) and 2-chloro-N-methoxy-N-methyl acetamide (245 mg, 0.95 mmol) to yield after purification 5 267 mg of product. MS 505. NMR

Example 108

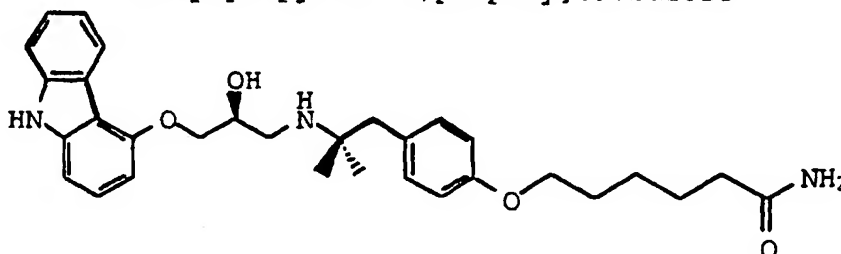
(S)-4-[2-Hydroxy-3-([4-(3-cyanopentoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



10 A mixture of the phenol prepared in example 91 (0.90 g, 2.2 mmol), 4-bromocaproonitrile (0.6 mL, 5.0 mmol), potassium carbonate (0.97 g, 7.0 mmol), potassium iodide (0.1 g) and methyl ethyl ketone (30 mL) was heated at reflux for 10 h. The reaction was concentrated in vacuo and the 15 resulting residue partitioned between EtOAc and water. The layers were separated and the aqueous layer extracted with EtOAc (3x). The combined organic layers were washed with water (3x), brine, dried (MgSO₄), and concentrated in vacuo to a light pink oil. The material was purified by flash 20 chromatography over silica gel eluting with 5% MeOH/CHCl₃ to provide 0.80 g (72%) of a clear oil. MS (FD+) 500.78 (MH⁺). NMR.

Example 109

25 (S)-4-[2-Hydroxy-3-([4-(3-carbamoylpentoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



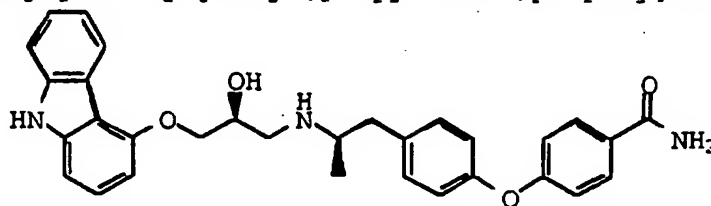
The nitrile prepared in example 108 (0.40 g, 0.80 mmol) and potassium carbonate (0.24 g, 1.70 mmol) were slurried in

-91-

DMSO (5 mL) and cooled to 0°C in an ice bath. Aqueous hydrogen peroxide (30%, 1.0 mL) was added slowly, and the reaction stirred at room temperature for 48 hours. The reaction was quenched by pouring into water, and extracting the aqueous layer with ethyl acetate. The combined organic layers were dried (MgSO₄), and concentrated in vacuo to a light tan oil. The material was purified by flash chromatography over silica gel eluting with EtOAc/hexanes/10% NH₄OH in MeOH (5:4:1) to provide 0.28 g (67%) of a colorless oil. MS (FD+) 518.07 (MH⁺). NMR.

Example 110

(S,R)-4-[2-Hydroxy-3-([4-(4-carbamoylphenoxy)phenyl]propylamino)propoxy]carbazole



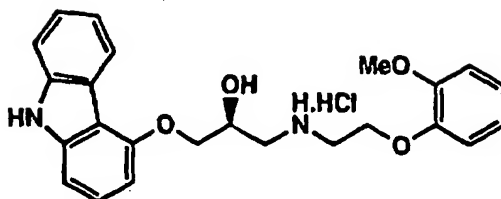
Trimethylsilylacetamide (0.26 g, 2.02 mmol) was added to a solution of the amine (0.50 g, 1.84 mmol) in DMSO (20 mL) and the mixture stirred at room temperature for 10 minutes before (S)-4-(oxiranylmethoxy)-9H-carbazole (0.44 g, 1.84 mmol) was added, and the resulting mixture heated at 66°C for 8 h. After cooling to room temperature, the reaction was quenched with 5% AcOH/MeOH (5 mL). The crude reaction mixture was filtered through a cation-exchange column (Varian Bond Elut 500 mg SCX), and the column washed with methanol (2 x 5 mL). The amine was then collected by rinsing the column with 2.0M ammonia in methanol (2 x 5 mL). The solvent was evaporated, and the crude material purified by flash chromatography (10% methanol/chloroform) to provide the desired compound (0.44g, 47%). MS (FD+) 511.1 (MH⁺). EA: Calculated for C₃₀H₃₀N₄O₄: C 70.57, H 5.92, N 10.97. Found: C 70.53, H 5.95, N 10.94.

Example 111

(S)-4-[2-Hydroxy-3-(2-[2-methoxyphenoxy]ethylamino)propoxy]carbazole

-92-

hydrochloride salt

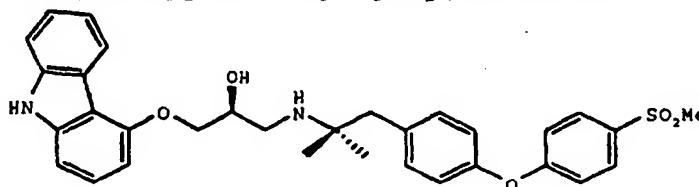


A solution of the product from preparation 96 (185 mg, 1.11 mmol) in ethanol (1 ml) was added (S)-4-oxiranylmethoxy)-9H-carbazole (87.9 mg, 0.37 mmol) in ethanol (5 ml) and the resulting solution was heated at 45°C for 19 h. The reaction mixture was concentrated under reduced pressure and residue was purified by flash chromatography (10:1 CHCl₃/MeOH) to yield the product as a white foam (86 mg, 58%); Mass spec, found 407.1.

The hydrochloride salt was prepared by dissolving the free base in isopropyl alcohol and adding one equivalent of hydrochloric acid (as a 4M solution in dioxane). The solvent was immediately removed under reduced pressure to yield the product as a white solid; Anal. calcd. for C₂₄H₂₇N₂O₄Cl: C, 65.08; H, 6.14; N, 6.32; Cl 8.00. Found: C, 64.86; H, 6.17; N, 6.02; Cl, 7.98.

Example 112

(S)-4-[2-Hydroxy-3-([4-(4-methylsulfonylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



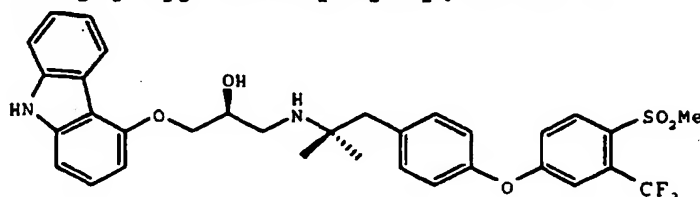
(S)-4-(oxiranylmethoxy)-9H-carbazole (0.3 g, 1.6 mmol) was added to 4-(4-(2-amino-2-methylpropyl)phenoxy)phenyl methylsulfone (1.0 g, 3.1 mmol) in 30 ml of ethanol with 2 drops of acetic acid and the reaction was heated to reflux for 16 hours. The reaction was cooled and concentrated in vacuo, and purified by column chromatography (8%

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methanol/EtOAc) to yield a pale yellow foam (664 mg).
MS(m+1) 510.

Example 113

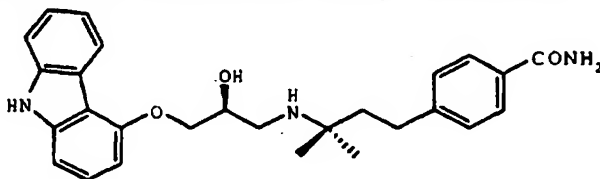
(S)-4-[2-Hydroxy-3-([4-(3-trifluoromethyl-4-methylsulfonylphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole



(S)-4-(oxiranylmethoxy)-9H-carbazole (0.335 g, 1.4 mmol) was added to 4-(4-(2-amino-2-methylpropyl)phenoxy)3-trifluoromethylphenyl methylsulfone (1.0 g, 3.1 mmol) in 30 ml of ethanol with 2 drops of acetic acid and the reaction was heated to reflux for 48 hours. The reaction was cooled, concentrated in vacuo, and purified by column chromatography (5% methanol/EtOAc) to yield a colorless oil (561 mg).
MS(m+1) 607.

Example 114

(S)-4-[2-Hydroxy-3-([4-carbamoylphenyl]-2-methylbutylamino)propoxy]carbazole

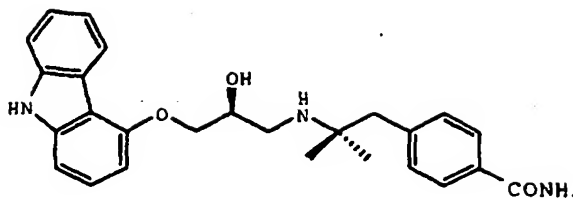


(S)-4-(oxiranylmethoxy)-9H-carbazole (0.479 g, 2 mmol) was added to 4-[3-amino-3-methylbutyl] benzamide (1.24 g, 6 mmol) in 60 ml of ethanol with 1 drop of acetic acid and the reaction was heated to 45°C for 18 hours. The reaction was cooled, concentrated in vacuo, and purified by preparative thinlayer chromatography (100% EtOAc) to yield product as the hydrate (150 mg). MS(m+1) 446. Anal. theory: C 72.78; H 7.01; N 9.43. Found: C 69.41; H 7.20; N 8.99.

Example 115

(S)-4-[2-Hydroxy-3-([4-carbamoylphenyl]-2-methylpropylamino)propoxy]carbazole

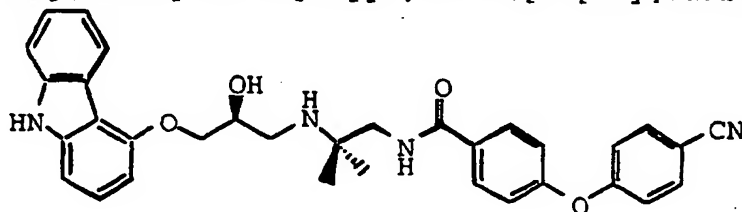
-94-



Titled compound was prepared substantially in accordance with Example 114 from (S)-4-(oxiranylmethoxy)-9H-carbazole (0.479 g, 2 mmol) and 4-[3-amino-3-methylpropyl] benzamide (580 mg, 3mmol) to yield product after
 5 purification. MS(m+1) 432.

Example 116

(S)-4-[2-Hydroxy-3-(2-methyl-2-N-[4-cyanophenoxy]benzoylamino)propyl]amino)propoxy]carbazole



10

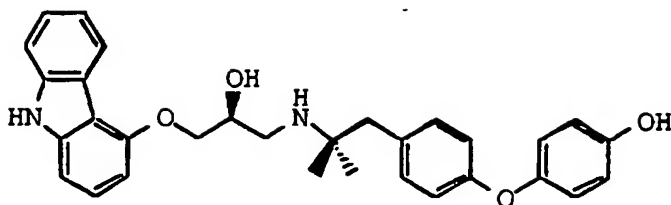
The amine from preparation 104 (0.430 g, 1.4 mmol) was combined with (S)-4-(oxiranylmethoxy)-9H-carbazole (0.225 g, 0.9 mmol) in EtOH (40 mL) and the mixture heated at 60°C for 20 hours. The mixture was then concentrated in vacuo and
 15 the resulting residue chromatographed over silica (1-10% MeOH/CHCl₃) which allowed for isolation of the product as the free base. The free base was then dissolved in minimal EtOAc and treated with diethyl ether saturated with HCl (20 mL). Filtration and drying netted 0.293 g (50%) of product
 20 as the HCl salt. MS (FD+): 549 m.p. 120-130 °C (dec) Anal. Calcd for C₂₇H₂₇N₃O₄·1.3HCl: C, 66.38; H, 5.63; N, 9.38. Found: C, 66.47; H, 5.54; N, 9.28.

Example 117

(S)-4-[2-Hydroxy-3-([4-(4-hydroxyphenoxy)phenyl]-2-methylpropylamino)propoxy]carbazole

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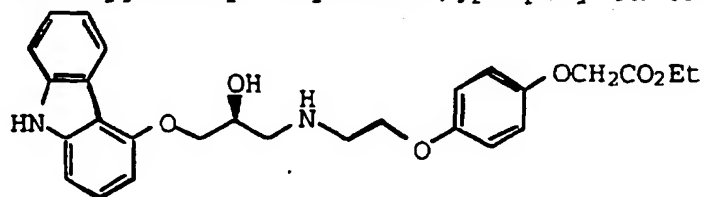


4-(4-(2-Methyl-2-aminopropyl)phenoxy)phenol (0.40 g, 1.55 mmol) was combined with (S)-4-(oxiranylmethoxy)-9H-carbazole (0.250 g, 1.0 mmol) in EtOH (50 mL) and the mixture heated at 60°C for 20 hours. The mixture was then concentrated in vacuo and the resulting residue chromatographed over silica (1-10% MeOH/CHCl₃) which allowed for isolation of the product as the free base. The free base was then dissolved in minimal EtOAc and treated with diethyl ether (25 mL) saturated with HCl. Filtration and drying netted 0.410 g (76%) of product as the HCl salt. MS (FD⁺):497. m.p. 80-85°C (dec). Anal. Calcd for C₂₁H₂₂N₂O₄·1.3HCl: C, 68.31; H, 6.16; N, 5.14. Found: C, 68.30; H, 6.75; N, 4.62.

15

Example 118

4-[2-Hydroxy-3-(2-(4-carboxyethylmethoxyphenoxy)ethylamino)]propoxy-9H-carbazole



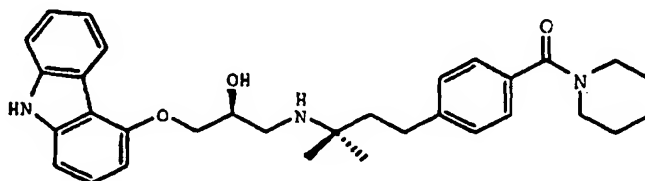
Ethyl-4-(2-aminoethyl)phenoxyacetate (0.270 g, 1.1 mmol) was combined with (S)-4-(oxiranylmethoxy)-9H-carbazole (0.200 g, 0.84 mmol) in EtOH (35 mL) and the mixture heated at 60°C for 20 hours. The mixture was then concentrated in vacuo and the resulting residue chromatographed over silica (CHCl₃) which allowed for isolation of the desired product as the free base 0.22 g (55%) as well as the undesired bis-product 0.12 g (40%). The free base was treated with diethyl ether (25 mL) saturated with HCl. Filtration and drying left the product as the HCl salt. MS (FD⁺) : 478 m.p. 57-61 °C

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(dec) Anal. Calcd for $C_{27}H_{29}N_2O_6 \cdot 1.85HCl$: C, 59.51; H, 5.71; N, 5.14. Found: C, 59.44; H, 5.86; N, 4.91.

Example 119

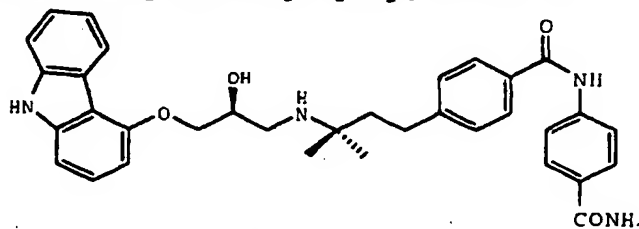
5 (S)-4-(3-[N-(4-[(4-carboxypiperidinyl)phenyl]-2-methyl)butylamino]-2-hydroxypropoxy)-9H-carbazole



10 Titled compound was prepared substantially in accordance with Example 118 from (S)-4-(oxiranylmethoxy)-9H-carbazole (0.77 g) and 4-(3-methyl-3-aminobutyl)benzoic acid piperidyl amide (0.234 g) to yield product (0.87 g) after purification. MS 513.

Example 120

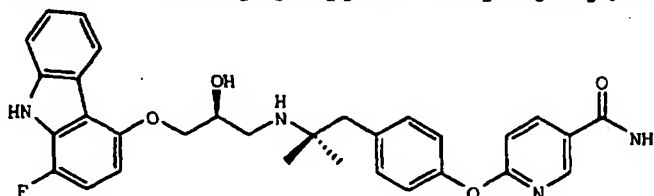
15 (S)-4-[2-Hydroxy-3-([4-(4-carbamoylphenylamido)phenyl]-2-methylbutylamino)propoxy]carbazole



20 Titled compound was prepared substantially in accordance with Example 118 from (S)-4-(oxiranylmethoxy)-9H-carbazole (0.73 g) and N-(Benzamid-4-yl)-N'-butyloxycarbonyl-4-(3-methyl-3-aminobutyl)benzamide (0.21 g) to yield product (0.87 g) after purification. MS 564.

Example 121

(S)-1-Fluoro-4-[2-hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole



25

The title compound was prepared substantially in accordance with Example 118 from a mixture of 4-(2-amino-2-

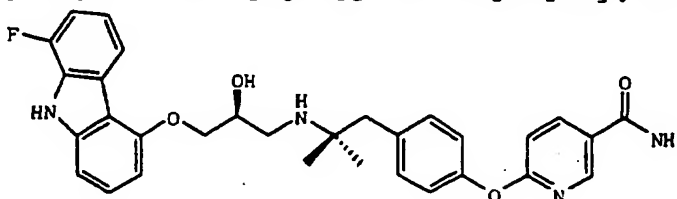
-97-

methylpropyl)phenoxy)-5-carboxamidepyridine (543 mg, 1.9 mmol) and (S)-1 fluoro-4-(oxiranylmethoxy)-9H-carbazole (245 mg, 0.95 mmol) to yield 417 mg of product.

Anal. Theory (1/4 H₂O): C 68.06; H 5.80; N 10.24. Found: C 67.97; H 5.83; N 9.70.

Example 122

(S)-1-Fluoro-5-[2-hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole

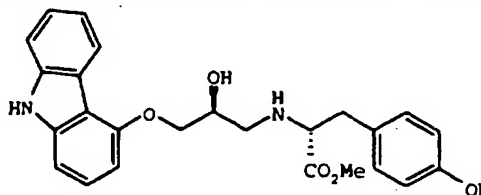


10

The title compound was prepared substantially in accordance with Example 118 from a mixture of 4-(2-amino-2-methylpropyl)phenoxy)-5-carboxamidepyridine (756 mg, 3.0 mmol) and (S)-1 fluoro-5-(oxiranylmethoxy)-9H-carbazole (385 mg, 1.5 mmol) to yield 750 mg of product. MS. Anal. Theory (.MeOH): C 66.18; H 6.14; N 9.75. Found: C 66.34; H 5.97; N 9.45.

Example 123

(S)-4-[2-Hydroxy-3-(2-[4-hydroxyphenyl]-1-carbomethoxyethylamino)propoxy]carbazole



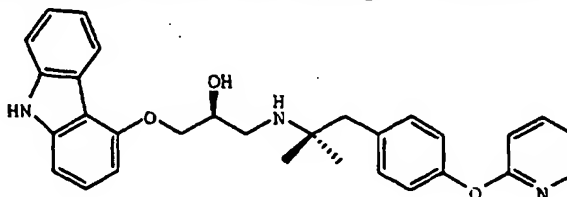
20

Titled compound was prepared substantially in accordance with Example 118 from (S)-4-(oxiranylmethoxy)-9H-carbazole (0.25 g) and L-tyrosine methylester (0.31 g) to yield product (0.26 g) after purification. MS 435. EA. NMR.

Example 124

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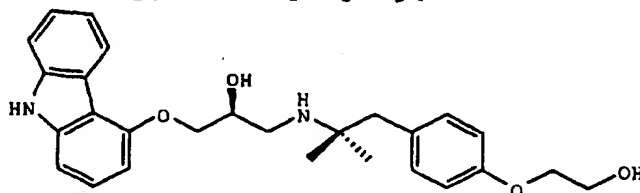
(S)-4-[2-Hydroxy-3-([4-(2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole



Titled compound was prepared substantially in accordance with Example 118 from (S)-4-(oxiranylmethoxy)-9H-carbazole (0.375 g) and 2-(4-(2-amino-2-methylpropyl)phenoxy)pyridine (0.496 g) to yield product (0.26 g) after purification. NMR.

Example 125

10 (S)-4-[2-Hydroxy-3-([4-(2-hydroxy-ethoxy)phenyl]-2-methylpropylamino)propoxy]carbazole

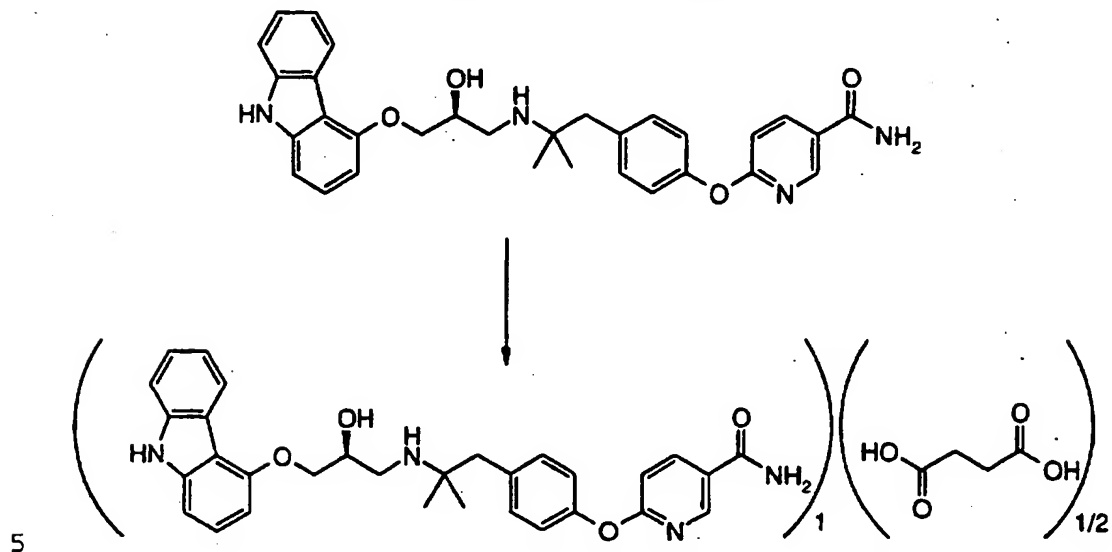


The title compound was prepared substantially in accordance with Example 118 from (S)-4-(oxiranylmethoxy)-9H-carbazole (329 mg, 1 mmol) and 1,1-dimethyl-2-(4-(2-hydroxy)ethoxy)phenylamine (460 mg, 2.2 mmol) to yield after purification 337 mg of product. MS 448. NMR

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Example 126

(S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole hemisuccinate salt



5 The freebase from example 87 (102.14 g, 194.69 mmol) in 511 mL of EtOAc and 1150 mL of EtOH was heated at 50-52°C until a clear amber solution was obtained. A solution of succinic acid (11.50 g, 97.34 mmol, 0.50 mole equivalents) in 200 mL of EtOH at 50°C was added to the solution. An additional 150 mL of EtOH was added. The resulting solution was allowed to cool. At 46°C the mixture was seeded. Product began to crystallize at 43°C. The mixture was stirred overnight at ambient temperature.

15 The resulting slurry was cooled to 10°C and filtered under vacuum. The filter cake was rinsed with 2x50 mL of 3:1 EtOH:EtOAc. The collected product was air dried under vacuum for 15 min. This gave a wet cake with a mass of 122 g. A sample (1.17 g) of the wet cake was dried under vacuum. ¹H NMR (500 MHz, DMSO-d₆) was consistent with the desired hemisuccinate salt containing approximately 1.3-1.6 mole equivalents ethanol: δ11.24 (s, 1H), 8.64 (d, 1H), 8.27-8.25 (m, 2H), 8.02 (s, 1H), 7.46-7.45 (d, 2H), 7.33-7.24 (m, 4H), 7.13-7.00 (m, 5H), 6.72-6.70 (s, 1H), 4.24-4.23 (d, 2H), 4.19-4.14 (m, 1H), 3.48-3.44 (q, 3.2H/2H = 1.6 mol equiv. EtOH), 3.13-3.10 (m, 1H), 3.00-2.97 (m, 1H), 2.76

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(s, 2H), 2.35 (s, 2H, -CH₂-CH₂- of ½ mole equivalent succinic acid), 1.08-1.06 (m, 10H of 6H 377604 + 4H/3H of 1.3 mol equiv. EtOH). The material was crystalline as determined by the x-ray diffraction pattern.

- 5 The recrystallization of the majority of the material and conversion to the amorphous solid from water are described below:

- The balance of the material was transferred back to the 3L flask with 1400 mL EtOH:EtOAc (3:1). The slurry was
10 heated to reflux (74°C pot temp) and an additional 200 mL solvent was added to provide a clear solution. A fritted glass filter was warmed with 100 mL hot solvent, and the solution was vacuum filtered into a 3L flask. The flask was rinsed with 2x100 mL solvent. Total solvent volume 1900 mL.
15 The hot filtrate was allowed to slowly cool to room temperature with stirring. Product began to crystallize at 46°C. The slurry was then stirred overnight.

- The mixture was cooled to 5°C in an ice/water bath and then vacuum filtered. The collected product was rinsed with
20 cold solvent mix (2x100 mL) and air dried under vacuum for approximately 15 min. The light cream free flowing solid was dried in a vacuum oven at 65°C overnight to give 109.6 g. A sample weighing 4.64 g was retained.

- The remainder of the material was transferred to a 2 L
25 flask with overhead stirring. To the material was added 400 mL of filtered DI water, and the resulting slurry was stirred for 5 hours at room temperature. The slurry was then vacuum filtered and collected solid was washed with water 3x100 mL. The product was air dried under vacuum for
30 approximately 2 hours. ¹H NMR indicated there was approximately one half mole EtOH remaining in the product. The material was allowed to stand at room temperature over a weekend.

- The solvate was converted to an amorphous form
35 containing only trace residual ethanol by slurring the solvate overnight in 400 mL of water. The mixture was vacuum filtered, and the filter cake was washed with water

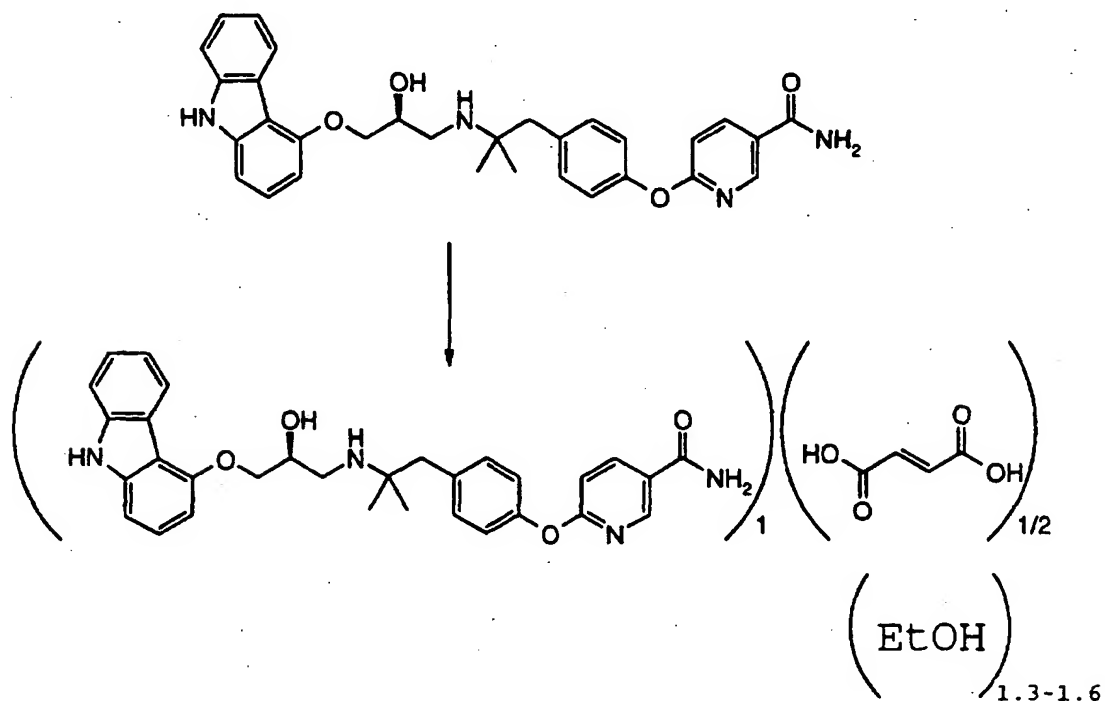
-101-

(3x100 mL). The solid was air dried under vacuum for approximately 2 hours then in a vacuum oven (65°C) overnight. This gave 85.92 g of product as an off white solid. Total Yield: 78.2% mp: 126-142°C

5

Example 127

(S)-4-[2-hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole hemifumarate salt ethanol solvate



10

The free base from example 87 (1.26 g, 2.40 mmol), 5 mL of EtOH, and 10 mL of EtOAc were heated at approximately 50-60 °C until a solution was obtained. A solution of fumaric acid (0.14 g, 1.20 mmol, 0.5 mole equivalents) in 5 mL of EtOH was added dropwise. A precipitate was formed during the addition. An additional 6.5 mL of EtOH and 4.5 mL of EtOAc was added and the mixture was heated to reflux. Some solids remained. An additional 2.5 mL of EtOH was added and the slurry was heated at reflux for 30 minutes. The slurry was allowed to cool for approximately 1 hour and then was cooled further in an ice bath. The product was collected by

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vacuum filtration, washed with 2x4 mL of cold 1:1 EtOH:EtOAc, and dried under vacuum. ¹H NMR (500 MHz, DMSO-d₆) was consistent with the desired hemifumarate salt containing approximately 1.3-1.6 mole equivalents ethanol: d11.25 (s, 5 1H), 8.64-8.63 (d, 1H), 8.27-8.25 (m, 2H), 8.0 (s, 1H), 7.46-7.44 (d, 2H), 7.33-7.25 (m, 4H), 7.11-7.02 (m, 5H), 6.72-6.70 (s, 1H), 6.53 (s, 1H, -CH=CH- of ½ mole equivalent of fumaric acid), 4.2-4.1 (m, 3H), 3.47-3.43 (q, 3.2H/2H = 1.6 mol equiv. EtOH), 3.18-3.10m, 1H), 3.05-2.95 10 (m, 1H), 2.80 (s, 2H), 1.11-1.05 (m, 10H of 6H 377604 + 4H/3H of 1.3 mol equiv. EtOH). The material was crystalline as determined by the x-ray diffraction pattern.

The following salt forms were prepared were prepared from (S)-4-[2-hydroxy-3-([4-(5-carbamoyl-2- 15 pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole substantially in accordance with Example 126 and Example 127.

Example 128

20 (S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole •(phosphate)_{1/2}

Example 129

(S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole •(sulfate)_{1/2}

25 Example 130

(S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole •(maleate)_{1/2}

Example 131

30 (S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole •(L-tartrate)_{1/2}

Example 132

(S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole •(citrate)_{1/2}

Example 133

35 (S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole •(glutarate)_{1/2}

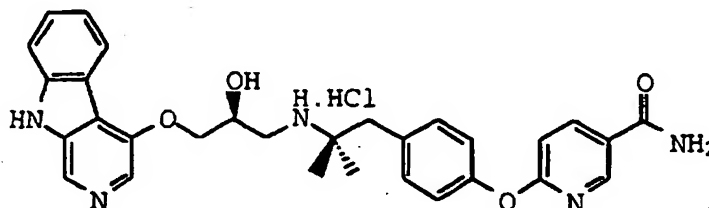
-103-

Example 134

(S)-4-[2-Hydroxy-3-([4-(5-carbamoyl-2-pyridyloxy)phenyl]-2-methylpropylamino)propoxy]carbazole • (malonate)_{1/2}

Example 134

5 (S)-4-[2-Hydroxy-3-(2-[4-phenoxy-5-carboxamidepyridin-2-yl]-
(2-methyl)propyl)amino)propoxy]-9H-pyrido[3,4-b]indole
hydrochloride salt



10

A mixture of 9H-pyrido[3,4-b]indol-4-ol (1.62 g, 8.79 mmol), (2S)-(+)-glycidyl 3-nitrobenzenesulfonate (2.28 g, 8.79 mmol), and powdered potassium carbonate (1.46 g, 10.55 mmol) in DMF (50 mL) was stirred at 40°C for 7 hours and
15 then placed in a freezer for 18 hours due to the instability of the product. The reaction mixture was poured into EtOAc/water (250 mL/150 mL). The layers were separated and the aqueous layer was washed with more EtOAc (250 mL) and EtOAc/THF (160 mL/80 mL). The organic portions were
20 combined and washed with brine (2 x 100 mL), dried (MgSO₄), filtered and evaporated in vacuo to provide the crude product as a dark orange oil.

An EtOH solution (200 mL) of the crude epoxide (8.8 mmol) and 2-(4-(2-amino-2-methylpropyl)phenoxy)-5-
25 carboxamidepyridine (5.02 g, 17.6 mmol, 2 eq) was heated at 70°C for 18 hr. A small amount of insoluble solids were filtered off and the filtrate evaporated in vacuo to provide an oil. Some solids crystallized from the oil and were triturated with MeOH. The MeOH was decanted to leave 5.20 g
30 of solid which by TLC contained starting amine and possible product. The MeOH portion was adsorbed on silica and passed through a silica pad with 90 CHCl₃/10 MeOH/1 NH₄OH to remove fast running impurities and then the product and starting amine were eluted together with 25 CHCl₃/5 MeOH/1 NH₄OH to

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give 2.35 g of a foam. The foam and the previous solids were combined (7.55 g), adsorbed on silica with CH₂Cl₂/MeOH, applied to a silica column, and then eluted with 25 EtOAc/5 MeOH/1 NH₄OH to give 5.60 g of product. Purification from gross impurities occurred but the starting amine and product had eluted together. The starting amine (1.23 g) was crystallized by allowing the mixture to stand in EtOAc/MeOH for 18 hr. The resulting filtrate was purified preparatively on a Waters 2000LC using a gradient elution of 9 EtOAc/1 MeOH to 65 EtOAc/20 CH₃CN/13 MeOH/2 isopropylamine to give 136 mg of product. The material was dissolved in EtOAc/MeOH (10 mL/2 mL), treated with 4N HCl in dioxane (0.063 mL, 1.02 eq) and then evaporated *in vacuo* to give 120 mg (2.4%) of product as the HCl salt. FD: MS (FD+) *m/z* 526

As previously noted, the compounds of the present invention are potent, selective β_3 receptor agonists. This pharmacological activity was determined in the functional agonist β_3 assay.

Functional Agonist Assays

Cell Lines

The h β_2 DNA was expressed from a plasmid 57537 obtained from American Type Culture Collection. h β_1 and h β_3 adrenergic receptors were cloned from human genomic libraries using the polymerase chain reaction method with degenerate probes. Full length receptors were cloned, expressed and sequenced to verify identity according to published sequences (h β_1 : T. Frielle et. al. (1993) Molecular Pharmacology 44: 264-270). These receptors were then expressed in the DXB-11 variant of CHO cells using a vector restoring tetrahydrofolate reductase and hygromycin resistance. Rat β_3 receptor expressing CHO cell line is known in the art. Mol. Pharm., Vol 40, pp. 895-99 (1991). CHO cells were grown in 10% dialyzed FBS./high glucose DMEM/0.1% proline.

cAMP Assay

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Cell membranes were harvested from the above cell line using hypotonic 25 mM Hepes (pH 7.4), 1 mM EDTA, 20 µg/mL leupeptin, 1 mM PMSF buffer with scraping followed by differential centrifugation. Membranes were incubated in 25 mM Tris (pH 7.6), 0.2% BSA, 2.6 mM Mg, 0.8 mM ATP, 0.1 mM GTP, 5 mM creatine phosphate, creatine kinase 50 U/mL, 0.2 mM IBMX at 32°C. Agonists were added and incubation continued for 15 m. cAMP produced was assayed using a fluorescent tracer-immuno assay method.

Intact cell assays were performed using suspended cells removed from culture flasks by trypsin treatment. Cells were preincubated with 0.5 mM IBMX at 37°C. Agonists were added and incubation continued for 15 min. Incubation was stopped by heating suspension in boiling water. cAMP or cGMP in these and the soleus incubations were assayed by RIA (Amersham).

The compounds of the invention are agonists of the β_3 receptor. Isoproterenol is accepted in the art as a non-selective β_3 agonist and is widely used as a comparator in evaluating the activity of compounds. See Trends in Pharm. Sci. 15: 3 (1994). In the Functional Agonist β_3 assay, the compounds demonstrated at least 30%, preferably 50% and most preferably over 85% of isoproterenol's response at a single dose of 50µmol. Dose response titrations on the agonists described reveal EC₅₀ values of < 10 mM, preferably < 1µmol. In the functional assay, dose titration furnishes an EC₅₀ for isoproterenol of 1.1±0.5 µM.

When screened against the β_1 and β_2 receptors in the functional assay, dose titration experiments indicate that greatly reduced or no receptor stimulation is observed with the compounds of the invention. This is defined by measuring the intrinsic activity (maximal response achieved) as compared to isoproterenol. The claimed compounds of Formula I are selective β_3 receptor agonists and have an intrinsic activity of < 3% of isoproterenol's response.

Thus, the compounds of the invention are selective β_3 agonists.

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As agonists of β_3 , the compounds are useful in treating conditions in a mammal in which the β_3 receptor has been demonstrated to have a role in pathology. The preferred mammal is a human. The relationship between modulating the β_3 receptor and treatment of diseases, such as Type II diabetes and obesity, is well established in the art. Other conditions recognized in the art include: gastrointestinal disorders such as gastrointestinal motility, asthma, depression, prostate disease and dyslipidemia. Thus, the present compounds are useful in the treatment of inflammatory bowel disease (Crohn's disease or ulcerative colitis), irritable bowel syndrome, non-specific diarrhoea and dumping syndrome.

In addition, administration of compounds of the present invention can result in normalization of insulin and glucose levels in patients requiring such normalization. Therefore, the present invention would be useful in treating hyperglycemia. The present invention would also be useful for increasing metabolic rate and enhancing a patients sensitivity to insulin.

In treating non-human mammals, the compounds of the present invention are useful for increasing weight gain and/or improving the feed utilization efficiency and/or weight gain and/or improving the feed utilization efficiency and/or increasing lean body mass and/or decreasing birth mortality rate and increasing post/natal survival rate of livestock.

The compounds of Formula I are preferably formulated prior to administration. Therefore, yet another embodiment of the present invention is a pharmaceutical formulation comprising a compound of Formula I and one or more pharmaceutically acceptable carriers, diluents or excipients.

The present pharmaceutical formulations are prepared by known procedures using well-known and readily available ingredients. In making the compositions of the

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present invention, the active ingredient will usually be mixed with a carrier, or diluted by a carrier, or enclosed within a carrier which may be in the form of a capsule, sachet, paper or other container. When the carrier serves
5 as a diluent, it may be a solid, semisolid or liquid material which acts as a vehicle, excipient or medium for the active ingredient. Thus, the compositions can be in the form of tablets, pills, powders, lozenges, sachets, cachets, elixirs, suspensions, emulsions, solutions, syrups, aerosol
10 (as a solid or in a liquid medium), soft and hard gelatin capsules, suppositories, sterile injectable solutions and sterile packaged powders.

Some examples of suitable carriers, excipients, and diluents include lactose, dextrose, sucrose, sorbitol,
15 mannitol, starches, gum acacia, calcium phosphate, alginates, tragacanth, gelatin, calcium silicate, microcrystalline cellulose, polyvinylpyrrolidone, cellulose, water syrup, methyl cellulose, methyl and propylhydroxybenzoates, talc, magnesium stearate and mineral
20 oil. The formulations can additionally include lubricating agents, wetting agents, emulsifying and suspending agents, preserving agents, sweetening agents or flavoring agents. The compositions of the invention may be formulated so as to provide quick, sustained or delayed release of the active
25 ingredient after administration to the patient.

The compositions are preferably formulated in a unit dosage form, each dosage containing from about 0.1 to about 500 mg, more usually about .5 to about 200 mg, of the active ingredient. However, it will be understood that the
30 therapeutic dosage administered will be determined by the physician in the light of the relevant circumstances including the condition to be treated, the choice of compound to be administered and the chosen route of administration, and therefore the above dosage ranges are
35 not intended to limit the scope of the invention in any way. The compounds can be administered by a variety of routes including the oral, rectal, transdermal, subcutaneous,

-108-

topical, intravenous, intramuscular or intranasal routes. For all indications, a typical daily dose will contain from about 0.05 mg/kg to about 20 mg/kg of the active compound of this invention. Preferred daily doses will be about 0.1 to about 10 mg/kg, ideally about 0.1 to about 5 mg/kg. However, for topical administration a typical dosage is about 1 to about 500 mg compound per cm² of an affected tissue. Preferably, the applied amount of compound will range from about 30 to about 300 mg/cm², more preferably, from about 50 to about 200 mg/cm², and, most preferably, from about 60 to about 100 mg/cm².

The following formulation examples are illustrative only and are not intended to limit the scope of the invention in any way.

15

Formulation 1

Hard gelatin capsules are prepared using the following ingredients:

	Quantity (mg/capsule)
Active ingredient	25
starch, dried	425
magnesium stearate	10
Total	<hr/> 460 mg

20

The above ingredients are mixed and filled into hard gelatin capsules in 460 mg quantities.

25

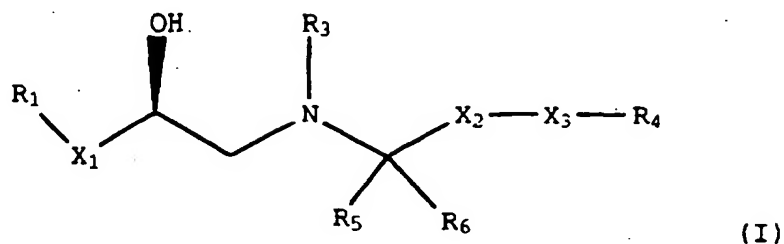
The principles, preferred embodiments and modes of operation of the present invention have been described in the foregoing specification. The invention which is intended to be protected herein, however, is not to be construed as limited to the particular forms disclosed, since they are to be regarded as illustrative rather than restrictive. Variations and changes may be made by those skilled in the art without departing from the spirit of the invention.

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We claim:

1. A method of stimulating the β_3 receptor which comprises administering to a patient in need thereof a compound of Formula I:

5



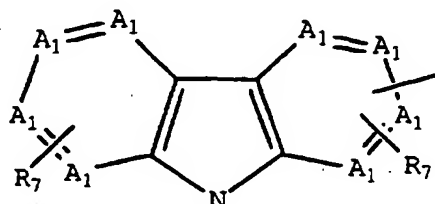
wherein:

X₁ is -OCH₂-, -SCH₂-, or a bond;

10 X₂ is a bond, or a 1 to 5 carbon straight or branched alkylene;

X₃ is O, S, or a bond;

R₁ is a fused heterocycle of the formula:



15

the A₁ groups are independently carbon or nitrogen, provided that no more than 2 nitrogens may be contained in either fused 6 membered ring and those 2 nitrogens may not be adjacent;

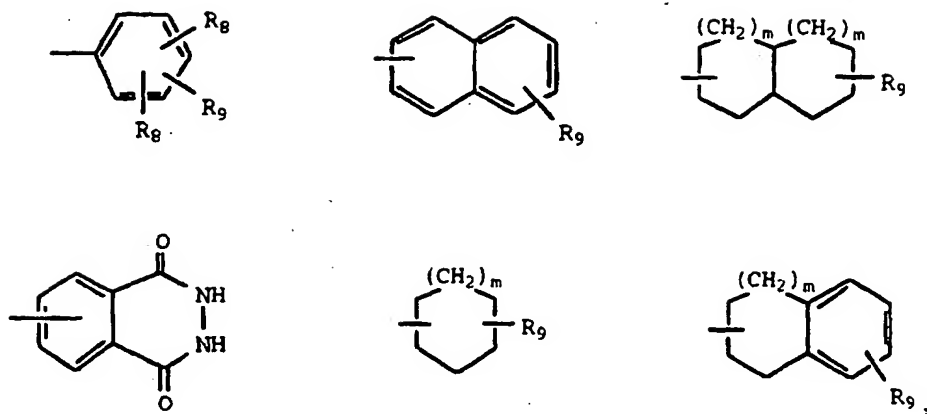
20 R₂ is independently hydrogen, C₁-C₄ alkyl, or aryl;

R₃ is hydrogen or C₁-C₄ alkyl;

R₄ is an optionally substituted heterocycle or a moiety selected from the group consisting of:

25

-110-



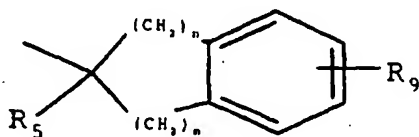
R₅ is hydrogen or C₁-C₄ alkyl;

R₆ is hydrogen, C₁-C₄ alkyl, or CO₂(C₁-C₄ alkyl);

5 or R₅ and R₆ combine with the carbon to which each is attached to form a C₃-C₆ cycloalkyl;

or R₆ combines with X₂ and the carbon to which each is attached to form a C₃-C₈ cycloalkyl;

10 or R₆ combines with X₂, R₄, and the carbon to which each is attached to form:



provided that R₅ is hydrogen;

15 R₇ is independently hydrogen, halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONR₂R₂, NHCOR₂, C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂;

R₈ is independently hydrogen, halo, or C₁-C₄ alkyl;

20 R₉ is hydrogen, halo, hydroxy, CN, OR₁₀, C₁-C₄ alkyl, C₁-C₄ haloalkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl or C₁-C₄ alkoxy), SR₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂, SOR₂, NR₁₁R₁₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂;

-111-

R₁₀ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted cycloalkyl, (CH₂)_n optionally substituted aryl, (CH₂)_n optionally substituted heterocycle,
 5 or (CH₂)_nCO₂R₂;

R₁₁ and R₁₂ are independently hydrogen, C₁-C₄ alkyl, aryl, (CH₂)_naryl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl;

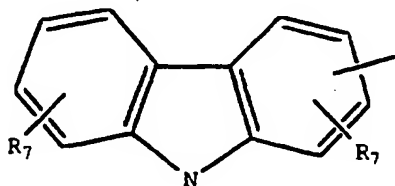
10 m is 0 or 1;

n is independently 0, 1, 2, or 3;

or a pharmaceutically acceptable salt or solvate thereof.

2. The method of Claim 1 wherein R₁ is

15



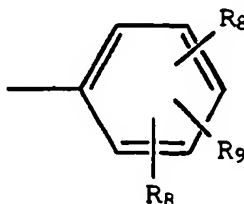
3. The method of Claim 2 wherein R₇ is hydrogen and R₃ is hydrogen.

20

4. The method of Claim 3 wherein X₃ is O or a bond.

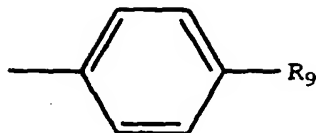
5. The method of Claim 4 wherein R₅ and R₆ are
 25 methyl, X₂ is methylene or ethylene, and X₃ is a bond.

6. The method of Claim 5 wherein R₄ is



-112-

7. The method of Claim 6 wherein R_4 is

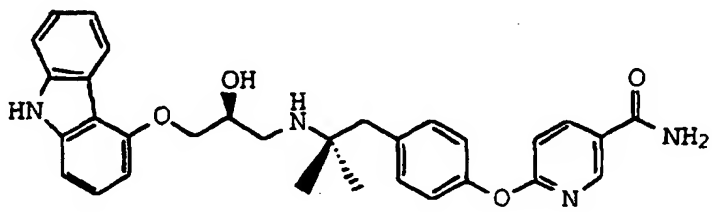


5 and R_9 is OR_{10} or $NR_2SO_2R_2$.

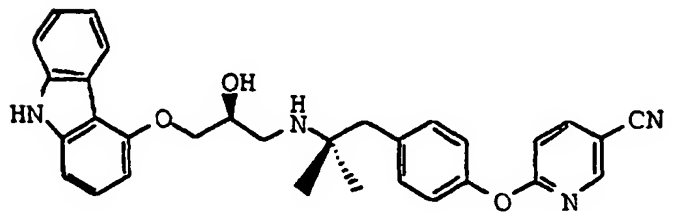
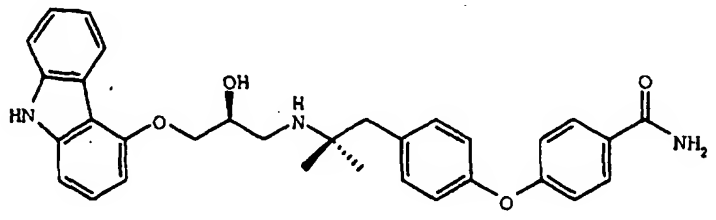
8. The method of Claim 7 wherein R_{10} is phenyl or pyridyl said phenyl or pyridyl being substituted with CN, hydroxy, $CONR_{11}R_{12}$, CO_2R_2 , SO_2R_2 , or $SO_2NR_{11}R_{12}$.

10

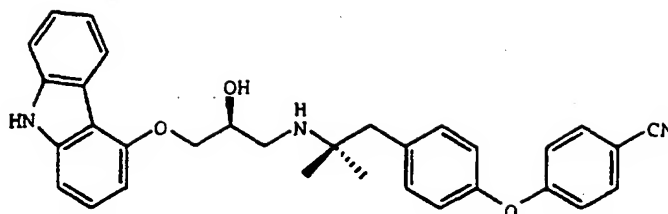
9. The method of Claim 8 wherein the compound is:



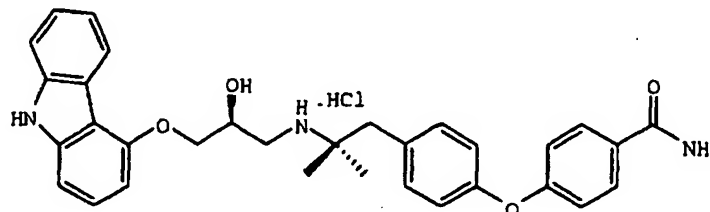
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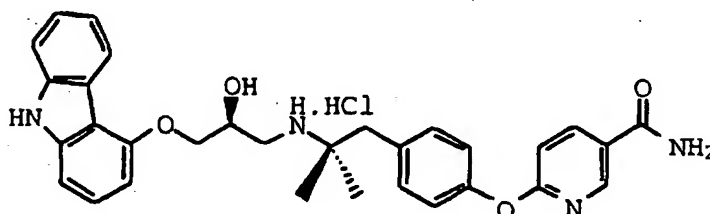
-113-



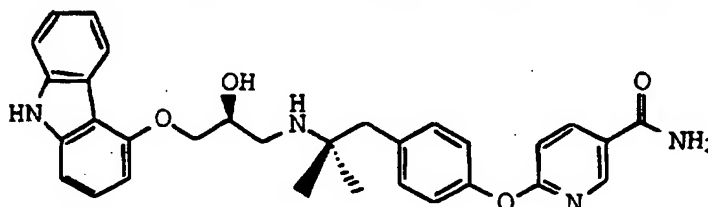
or a pharmaceutically acceptable salt or solvate thereof; or



; or

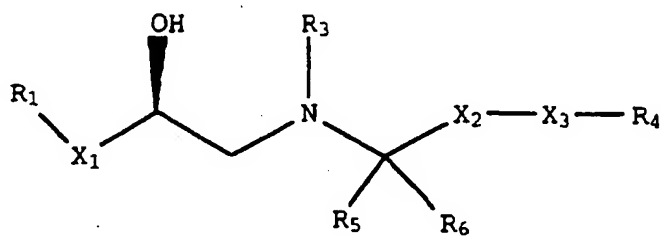


10. The method of claim 9 wherein the compound is



10 or a pharmaceutically acceptable salt or solvate.

11. A method of treating obesity which comprises administering to a patient in need thereof a compound of Formula I:



(I)

wherein:

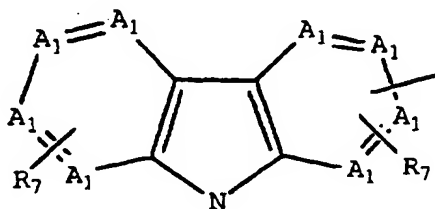
-114-

X₁ is -OCH₂-, -SCH₂-, or a bond;

X₂ is a bond, or a 1 to 5 carbon straight or branched alkylene;

X₃ is O, S, or a bond;

5 R₁ is a fused heterocycle of the formula:

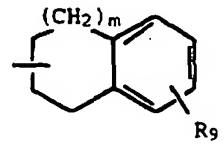
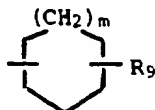
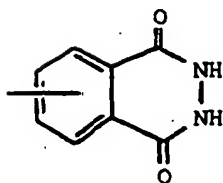
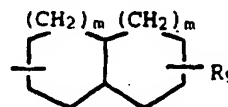
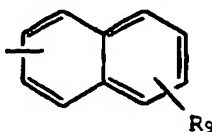
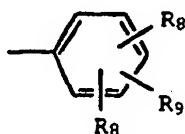


the A₁ groups are independently carbon or
10 nitrogen, provided that no more than 2 nitrogens may be contained in either fused 6 membered ring and those 2 nitrogens may not be adjacent;

R₂ is independently hydrogen, C₁-C₄ alkyl, or aryl;

15 R₃ is hydrogen or C₁-C₄ alkyl;

R₄ is an optionally substituted heterocycle or a moiety selected from the group consisting of:



20

R₅ is hydrogen or C₁-C₄ alkyl;

R₆ is hydrogen, C₁-C₄ alkyl, or CO₂(C₁-C₄ alkyl);

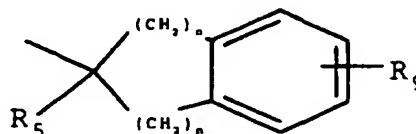
or R₅ and R₆ combine with the carbon to which each is attached to form a C₃-C₆ cycloalkyl;

-115-

or R₆ combines with X₂ and the carbon to which each is attached to form a C₃-C₈ cycloalkyl;

or R₆ combines with X₂, R₄, and the carbon to which each is attached to form:

5



provided that R₅ is hydrogen;

R₇ is independently hydrogen, halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONR₂R₂, NHCOR₂,
 10 C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂;

R₈ is independently hydrogen, halo, or C₁-C₄ alkyl;

R₉ is hydrogen, halo, hydroxy, CN, OR₁₀, C₁-C₄ alkyl, C₁-C₄ haloalkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl
 15 or C₁-C₄ alkoxy), SR₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂, SOR₂, NR₁₁R₁₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂;

R₁₀ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈
 20 cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted cycloalkyl, (CH₂)_n optionally substituted aryl, (CH₂)_n optionally substituted heterocycle, or (CH₂)_nCO₂R₂;

R₁₁ and R₁₂ are independently hydrogen, C₁-C₄
 25 alkyl, aryl, (CH₂)_naryl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl;

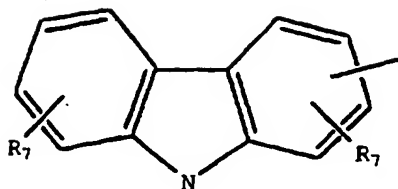
m is 0 or 1;

n is independently 0, 1, 2, or 3;

30 or a pharmaceutically acceptable salt or solvate thereof.

12. The method of Claim 11 wherein R₁ is

-116-



13. The method of Claim 12 wherein R₇ is hydrogen and R₃ is hydrogen.

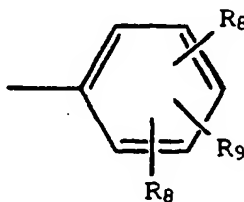
5

14. The method of Claim 13 wherein X₃ is O or a bond.

15. The method of Claim 14 wherein R₅ and R₆ are methyl, X₂ is methylene or ethylene, and X₃ is a bond.

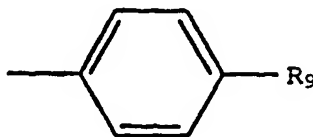
10

16. The method of Claim 15 wherein R₄ is



15

17. The method of Claim 16 wherein R₄ is



and R₉ is OR₁₀ or NR₂SO₂R₂.

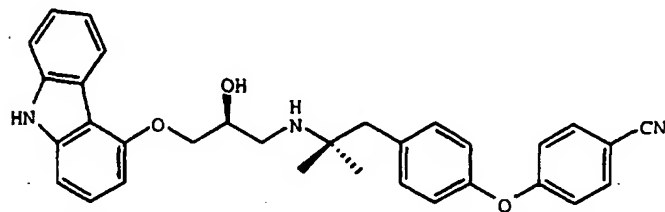
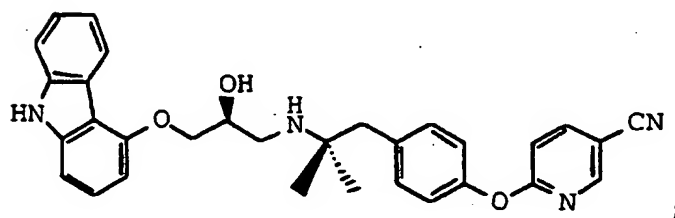
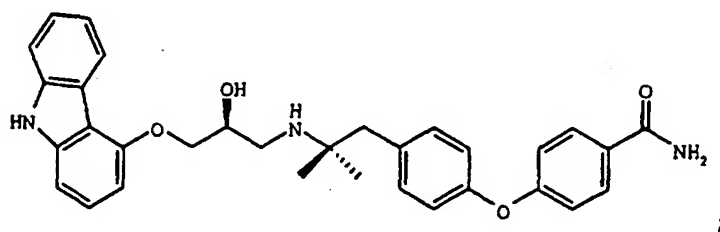
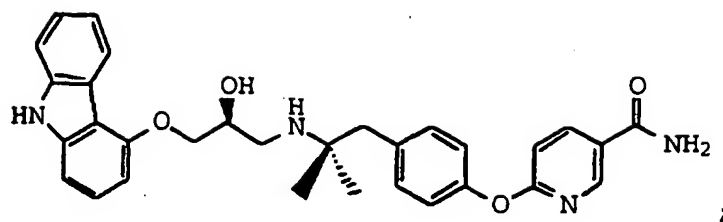
20

18. The method of Claim 17 wherein R₁₀ is phenyl or pyridyl said phenyl or pyridyl being substituted with CN, hydroxy, CONR₁₁R₁₂, CO₂R₂, SO₂R₂, or SO₂NR₁₁R₁₂.

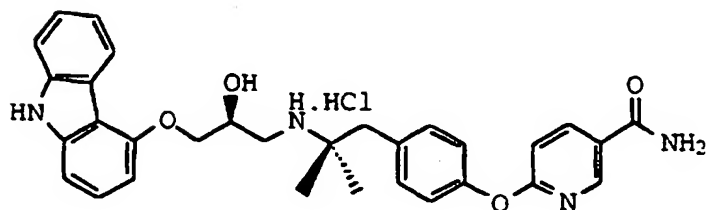
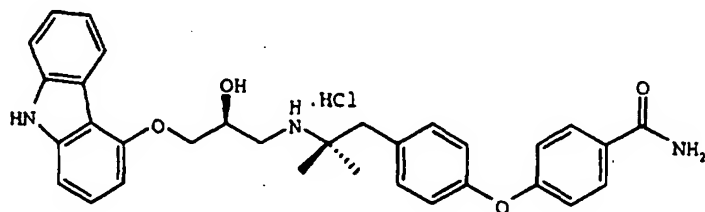
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19. The method of Claim 18 wherein the compound is:

-117-

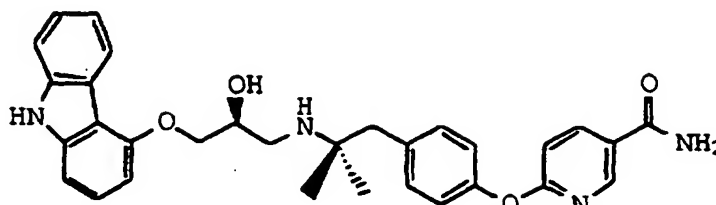


or a pharmaceutically acceptable salt or solvate thereof; or



-118-

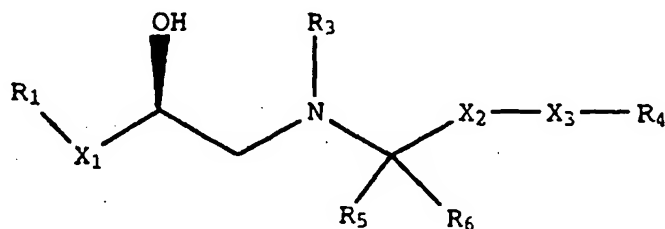
20. The method of claim 19 wherein the compound is



or a pharmaceutically acceptable salt or solvate thereof.

5

21. A method of treating Type II diabetes which comprises administering to a patient in need thereof a compound of Formula I:



(I)

10

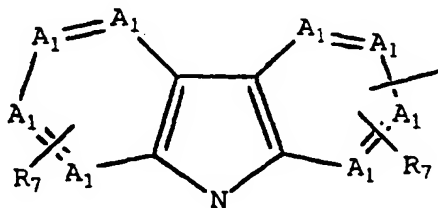
wherein:

X₁ is -OCH₂-, -SCH₂-, or a bond;

X₂ is a bond, or a 1 to 5 carbon straight or branched alkylene;

15 X₃ is O, S, or a bond;

R₁ is a fused heterocycle of the formula:



20 the A₁ groups are independently carbon or nitrogen, provided that no more than 2 nitrogens may be contained in either fused 6 membered ring and those 2 nitrogens may not be adjacent;

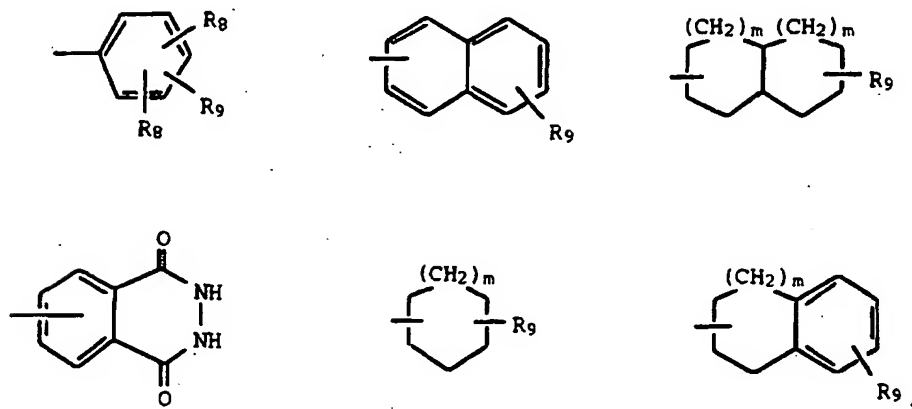
R₂ is independently hydrogen, C₁-C₄ alkyl, or

25 aryl;

R₃ is hydrogen or C₁-C₄ alkyl;

-119-

R₄ is an optionally substituted heterocycle or a moiety selected from the group consisting of:



5

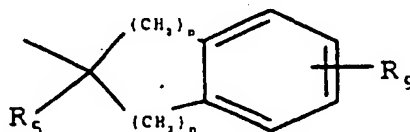
R₅ is hydrogen or C₁-C₄ alkyl;

R₆ is hydrogen, C₁-C₄ alkyl, or CO₂(C₁-C₄ alkyl);

or R₅ and R₆ combine with the carbon to which each is attached to form a C₃-C₆ cycloalkyl;

10 or R₆ combines with X₂ and the carbon to which each is attached to form a C₃-C₈ cycloalkyl;

or R₆ combines with X₂, R₄, and the carbon to which each is attached to form:



15

provided that R₅ is hydrogen;

R₇ is independently hydrogen, halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONR₂R₂, NHCOR₂, C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂;

20 R₈ is independently hydrogen, halo, or C₁-C₄ alkyl;

R₉ is hydrogen, halo, hydroxy, CN, OR₁₀, C₁-C₄ alkyl, C₁-C₄ haloalkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl or C₁-C₄ alkoxy), SR₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂R₂,
25 SO₂NR₁₁R₁₂, SOR₂, NR₁₁R₁₂, optionally substituted aryl,

- 120 -

optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂;

R₁₀ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted cycloalkyl, (CH₂)_n optionally substituted aryl, (CH₂)_n optionally substituted heterocycle, or (CH₂)_nCO₂R₂;

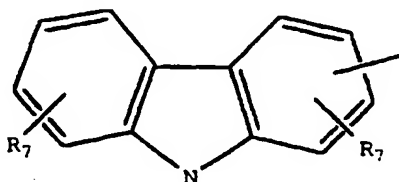
R₁₁ and R₁₂ are independently hydrogen, C₁-C₄ alkyl, aryl, (CH₂)_naryl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl;

m is 0 or 1;

n is independently 0, 1, 2, or 3;

or a pharmaceutically acceptable salt or solvate thereof.

22. The method of Claim 21 wherein R₁ is



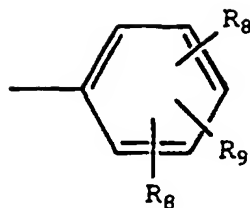
23. The method of Claim 22 wherein R₇ is hydrogen and R₃ is hydrogen.

24. The method of Claim 23 wherein X₃ is O or a bond.

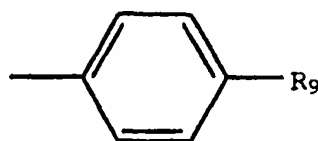
25. The method of Claim 24 wherein R₅ and R₆ are methyl, X₂ is methylene or ethylene, and X₃ is a bond.

26. The method of Claim 25 wherein R₄ is

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27. The method of Claim 26 wherein R_4 is



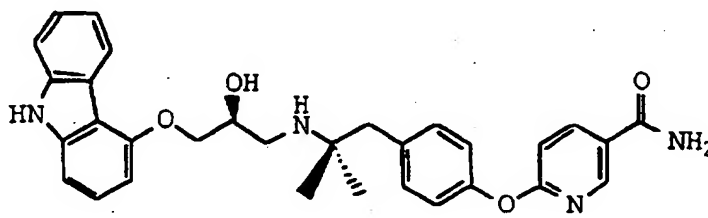
5

and R_9 is OR_{10} or $NR_2SO_2R_2$.

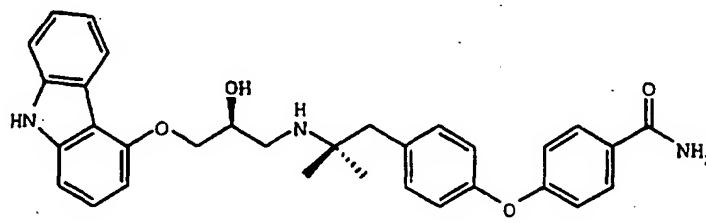
28. The method of Claim 27 wherein R_{10} is phenyl or pyridyl said phenyl or pyridyl being substituted with CN, hydroxy, $CONR_{11}R_{12}$, CO_2R_2 , SO_2R_2 , or $SO_2NR_{11}R_{12}$.

10

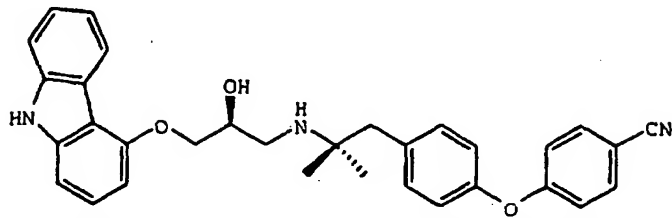
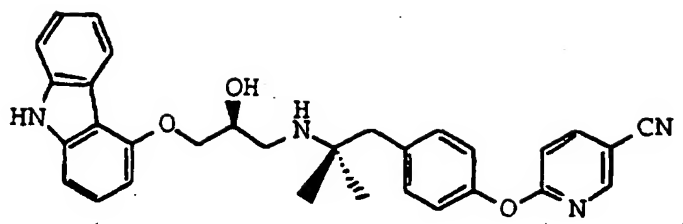
29. The method of Claim 28 wherein the compound is:



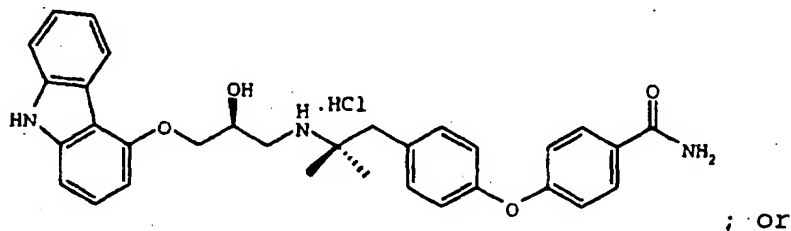
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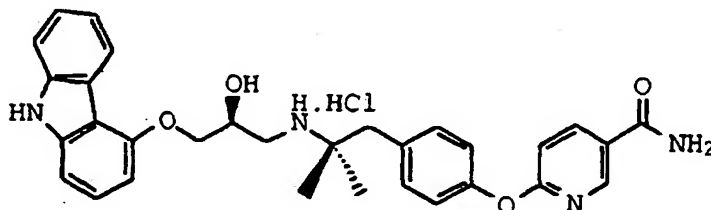
-122-



or a pharmaceutically acceptable salt or solvate thereof; or

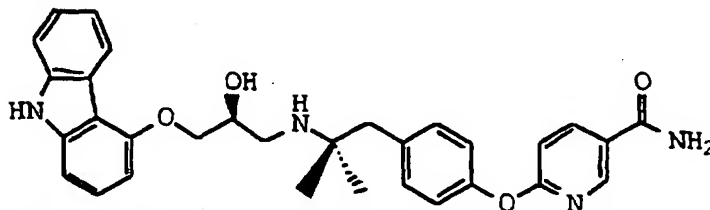


; or



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30. The method of claim 29 wherein the compound is

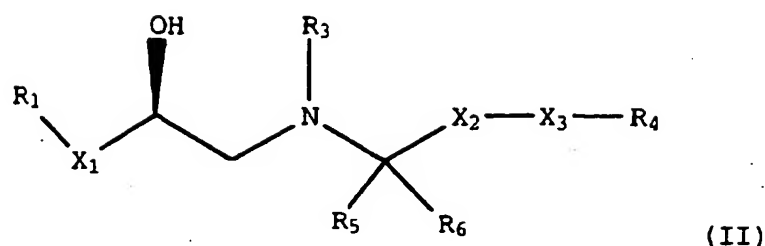


or a pharmaceutically acceptable salt or solvate.

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31. A compound of the Formula II

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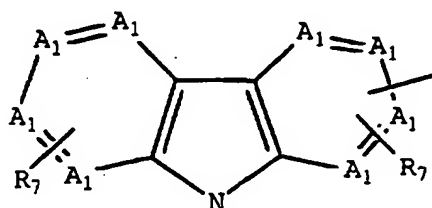


wherein:

X₁ is -OCH₂-, -SCH₂-, or a bond;

X₃ is O, S, or a bond;

5 R₁ is a fused heterocycle of the formula:



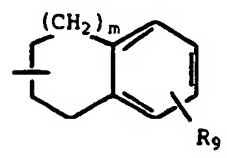
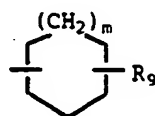
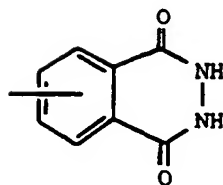
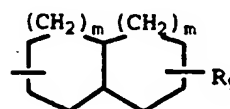
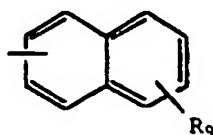
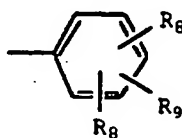
the A₁ groups of said heterocycle are

10 independently carbon or nitrogen, provided that no more than 2 nitrogens may be contained in either fused 6 membered ring and those 2 nitrogens may not be adjacent;

R₂ is independently hydrogen, C₁-C₄ alkyl, or aryl;

15 R₃ is hydrogen or C₁-C₄ alkyl;

R₄ is an optionally substituted heterocycle or a moiety selected from the group consisting of:



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X₂ is a bond, or a 1 to 5 carbon straight or branched alkylene;

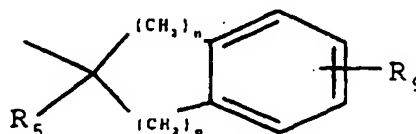
R₅ is hydrogen or C₁-C₄ alkyl;

R₆ is hydrogen, C₁-C₄ alkyl, or CO₂(C₁-C₄ alkyl);

5 or R₅ and R₆ combine with the carbon to which each is attached to form a C₃-C₆ cycloalkyl;

or R₆ combines with X₂ and the carbon to which each is attached to form a C₃-C₈ cycloalkyl;

10 or R₆ combines with X₂, R₄, and the carbon to which each is attached to form:



provided that R₅ is hydrogen;

15 R₇ is independently hydrogen, halo, hydroxy, OR₂, C₁-C₄ alkyl, C₁-C₄ haloalkyl, aryl, COOR₂, CONHR₂, NHCOR₂, C₁-C₄ alkoxy, NHR₂, SR₂, CN, SO₂R₂, SO₂NHR₂, or SOR₂;

R₈ is independently hydrogen, halo or C₁-C₄ alkyl;

20 R₉ is halo, CN, OR₁₀, C₁-C₄ alkyl, C₁-C₄ haloalkyl, CO₂R₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkyl or C₁-C₄ alkoxy), SR₂, CSNR₂, CSNR₁₁R₁₂, NR₂SO₂R₂, SO₂R₂, SO₂NR₁₁R₁₂, SOR₂, NR₁₁R₁₂, optionally substituted aryl, optionally substituted heterocycle, or C₂-C₄ alkenyl substituted with CN, CO₂R₂ or CONR₁₁R₁₂;

25 R₁₀ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, (CH₂)_nC₃-C₈ cycloalkyl, (CH₂)_naryl, (CH₂)_nheterocycle, (CH₂)_nC₃-C₈ optionally substituted cycloalkyl, (CH₂)_n optionally substituted aryl, (CH₂)_n optionally substituted heterocycle, or (CH₂)_nCO₂R₂;

30 R₁₁ and R₁₂ are independently hydrogen, C₁-C₄ alkyl, aryl, (CH₂)_naryl, or combine with the nitrogen to which each is bound to form morpholinyl, piperidinyl, pyrrolidinyl, or piperazinyl;

m is 0 or 1;

n is independently 0, 1, 2, or 3;

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provided:

when R_5 or R_6 is hydrogen; either1) one or more A_1 must be nitrogen,

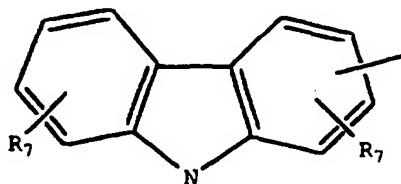
or

- 5 2) R_9 is CN, OR_{10} , CO_2R_2 , $CSNR_2$, $CSNR_{11}R_{12}$,
 $NR_2SO_2R_2$, $SO_2NR_{11}R_{12}$, optionally substituted aryl,
 optionally substituted heterocycle, or C₂-C₄ alkenyl
 substituted with CN, CO_2R_2 or $CONR_{11}R_{12}$; and

- 10 R_{10} is C₁-C₄ haloalkyl, $(CH_2)_n$ C₃-C₈ cycloalkyl,
 $(CH_2)_n$ heterocycle, $(CH_2)_n$ C₃-C₈ optionally substituted
 cycloalkyl, $(CH_2)_n$ optionally substituted aryl, or $(CH_2)_n$
 optionally substituted heterocycle;
 or a pharmaceutically acceptable salt or solvate thereof.

- 15 32. A compound of Claim 31 wherein R_5 and R_6 are
 methyl or ethyl.

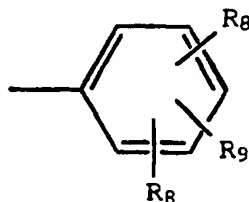
33. A compound of Claim 32 wherein R_1 is



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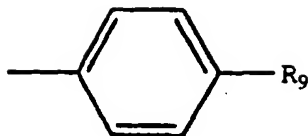
34. A compound of Claim 33 wherein X_2 is
 methylene or ethylene.

- 25 35. A compound of Claim 34 wherein R_4 is



36. A compound of Claim 35 wherein R_4 is

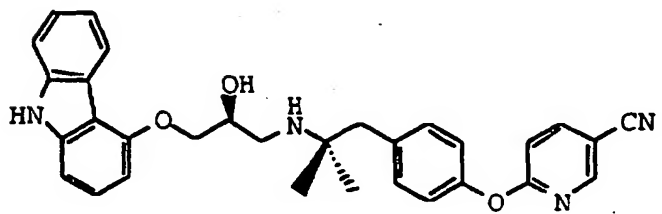
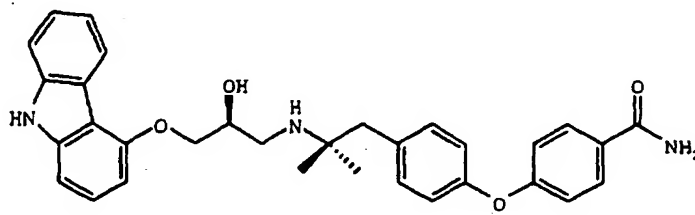
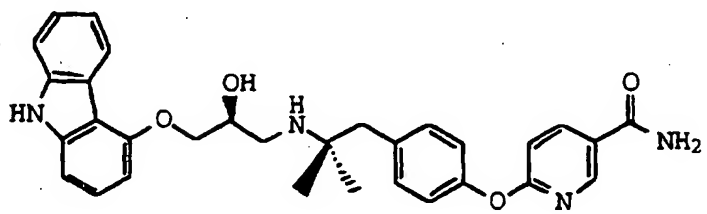
-126-



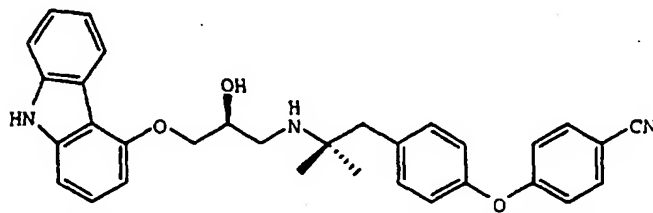
and R_9 is OR_{10} or $NR_2SO_2R_2$.

- 5 37. A compound of Claim 36 wherein R_{10} is phenyl or pyridyl said phenyl or pyridyl being substituted with CN, $CONR_{11}R_{12}$, CO_2R_2 , SO_2R_2 , or $SO_2NR_{11}R_{12}$.

- 10 38. A compound of Claim 37 which is:

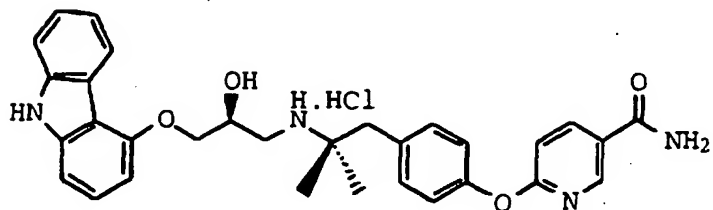
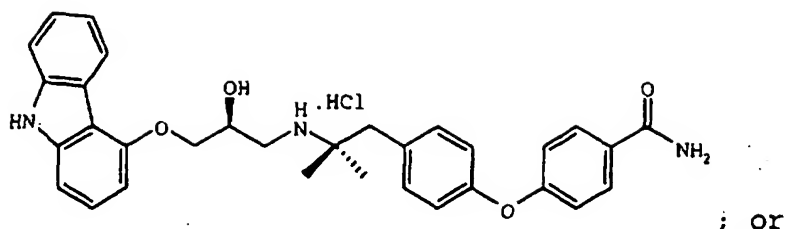


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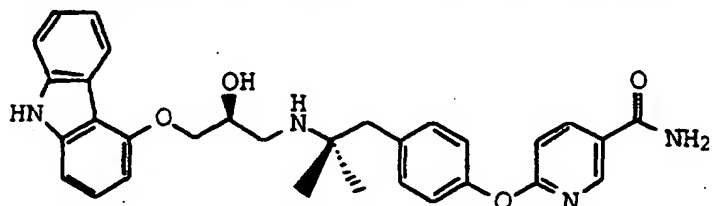


or a pharmaceutically acceptable salt or solvate thereof; or

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39. The compound of claim 38 of the formula



or a pharmaceutically acceptable salt or solvate.

40. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 31, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

41. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 32, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

42. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 33, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

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43. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 34, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

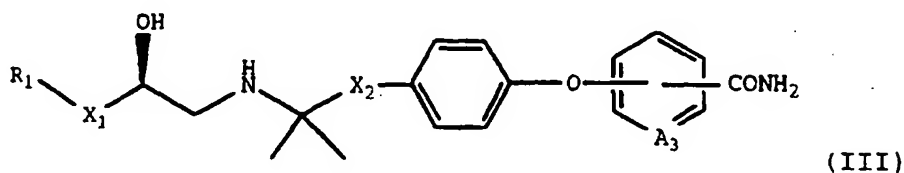
44. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 35, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

45. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 36, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

46. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 38, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

47. A pharmaceutical formulation comprising as an active ingredient a compound of Claim 39, associated with one or more pharmaceutically acceptable carriers, excipients or diluents.

48. A process of preparing a compound of claim 31 of the formula III:



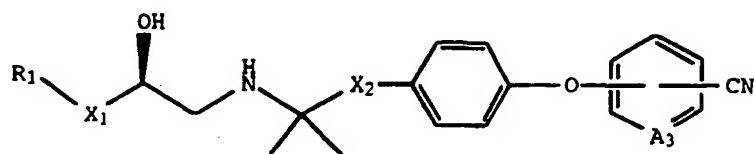
wherein:

A₃ is CH or N;

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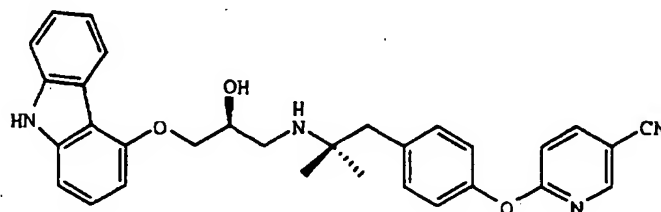
which comprises:

in step 1, hydrolysis of a compound of the formula:



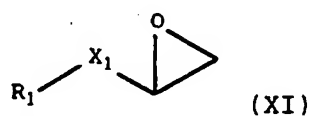
and optionally in step 2, reacting the product of step 1 with an acid to form an acid addition salt.

49. The process of claim 48 wherein in step 1 the hydrolysis is of a compound of the formula

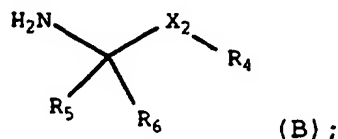


50. A process of preparing a compound of Claim 31, which comprises:

in step 1, reacting an epoxide of the formula XI:



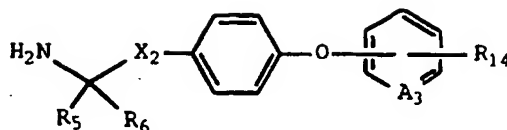
with an amine of formula B:



and optionally in step 2, reacting the product of step 1 with an acid to form an acid addition salt.

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51. A process of Claim 50, wherein the amine is of the formula:



wherein:

A₃ is CH or N;

R₁₄ is C₁-C₄ alkyl, C₁-C₄ haloalkyl, hydroxy, carboxy, tetrazolyl, acyl, COOR₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkoxy), cyano, C₁-C₄ alkoxy, C₁-C₄ alkyl, phenyl, nitro, NR₁₁R₁₂, NHCO(C₁-C₄ alkyl), NHCO(benzyl), NHCO(phenyl), SR₂, S(C₁-C₄ alkyl), OCO(C₁-C₄ alkyl), SO₂(NR₁₁R₁₂), SO₂(C₁-C₄ alkyl), or SO₂(phenyl).

52. The process of claim 50 wherein;

A₃ is N; and

R₁₄ is COOR₂, CONR₁₁R₁₂, CONH(C₁-C₄ alkoxy), or cyano.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/15230

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A61K 31/40, 31/44; C07D 209/82, 209/88, 401/12

US CL :514/339, 411; 546/276.7; 548/444

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 514/339, 411; 546/276.7; 548/444

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

STN CAS ONLINE, APS (OBESITY, DIABETES, RECEPTOR?)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,503,067 A (WIEDEMANN ET AL.) 05 March 1985 (05/03/85), see entire document, especially Examples 1 and 2, column 5; Example 3, column 6; Example 4, column 8; etc.	31-36, 40-44

☐ Further documents are listed in the continuation of Box C.☐ See patent family annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

B earlier document published on or after the international filing date

L document which may throw doubt on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

A

document member of the same patent family

Date of the actual completion of the international search

06 OCTOBER 1997

Date of mailing of the international search report

12 NOV 1997

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Authorized officer

LAURA L. STOCKTON

Telephone No. (703) 308-1235

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/15230

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 21, 23-30, 39 and 46
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Please See Extra Sheet.

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
☐ No protest accompanied the payment of additional search fees.

Form PCT/ISA/210 (continuation of first sheet)(1)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US97/15230

BOX I. OBSERVATIONS WHERE CLAIMS WERE FOUND UNSEARCHABLE

2. Where no meaningful search could be carried out, specifically:

There are two claims numbered claim 21 and two claims numbered claim 39. Since it is not clear which claims are properly numbered claims 21 and 39, a meaningful search could not be done on any of these claims. Claims 23-30 and claim 46 could not be searched because they are dependent on claims 21 and 39, respectively.

Form PCT/ISA/210 (extra sheet)(July 1992)*

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